OCT 4 1932

Engineering

THE ELECTRICAL WORLD

A Weekly Review of Current Progress in Electricity and its Practical Applications

OCTOBER 1, 1932 . . . *FIFTY YEARS OF ELECTRICAL PROGRESS* . . . One Dollar per Copy
McGraw-Hill Publishing Company Inc.

"Be courageous . . . have faith . . . go forward"

This picture was released to the editors through courtesy of Kuhlman Electric Company

..this FOOT-CANDLE METER can be Your Strongest Selling Aid

Pocket-sized . . . reliable . . . low-priced! Simple . . . easy to use as a voltmeter or pocket-rule! A handy portable means for your customers, your salesmen, yourself, to measure the intensity of illumination without guesswork or calculation.

This Foot-Candle Meter can make your customers light-conscious . . . your salesmen can nail down their talk with definite facts—"You need 200 Foot-Candles for this window. You have only 90. Measure it yourself!" And that storekeeper, factory manager, or whoever he may be, will not stop with the one measurement. He will want to check every spot in his store or plant. It's human nature. Nine out of ten chances, he will prove to himself that his store or plant is under-illuminated. The rest is up to your salesmen.

The use of this Foot-Candle Meter by lighting salesmen can crystallize the extensive publicity and advertising that has been accorded illumination during the past years. It permits them to get down to specific indisputable facts.

If you yourself have not already used this new Foot-Candle Meter, call the nearest Weston office today. It offers both sellers and buyers of light one of the greatest opportunities they have ever had.

WESTON

ELECTRICAL INSTRUMENT CORPORATION

578 FRELINGHUYSEN AVENUE · · · · NEWARK, N. J.

THE ELECTRICAL WORLD

OCTOBER 1, 1932 *FIFTY YEARS OF ELECTRICAL PROGRESS* Established 1883 McGraw-Hill Publishing Company, Inc.

Edison Institute, Dearborn, Mich. Designed after Independence Hall in Philadelphia. Erected by Henry Ford as a tribute to Edison.

Employee Benefit Plan Adopted in Los Angeles

Said to be the most comprehensive pension, life insurance and health and accident insurance plan to be instituted this year by any American industry, employees of Los Angeles Gas & Electric and other Pacific Lighting units will be protected by a new arrangement, just announced. The plan affects the well-being of the 6,200 employees. It replaces the pension and benefit plans which have been carried on separately for a number of years by the various co-operating organizations.

The pension feature provides for the retirement of women at age 60 and men at age 65. It also calls for participation in the cost by employees to the extent of 3 per cent of their monthly salaries. This is matched by a larger contribution by the companies. Employee deposits in the pension fund are returnable in full, with accrued compound interest, in event of the employee leaving the service before retirement. The death benefit and disability benefit features of the plan are provided for employees entirely at the expense of the companies of the Pacific Lighting group.

Approximately $633,350 a year will be paid into the fund by the companies, while about $300,000 will be deposited each year by employees.

EDISON IS GOING TO LIGHT THE WORLD!

Through a series of quotations and abstracts from the "Electrical World" of 1882, 1883 and 1884 (the *Operator* in 1882) the editors have endeavored in this issue to recreate the atmosphere that enveloped the early struggles of the electrical industry, which began with the establishment of the Pearl Street station by Edison, on September 4, 1882, and foretold not at all the stupendous development of the 50 years which were to follow.

Today perhaps electrical industry men stand no more aware of the tremendous prospects of their industry and of our nation than did the hardy, determined pioneers who laid the foundations for things as they have become.

The future is ever obscured.

Duquesne Rate Offer Accepted by Pittsburgh

Following six months of negotiation between the city of Pittsburgh and the Duquesne Light Company, new electric rates, providing savings of from 5 cents to 20 cents a month to the average domestic consumer, were agreed upon, effective October 1. The aggregate reduction amounts to approximately $750,000 a year. The City Council accepted the offer of the company on the following recommendation of City Solicitor Charles A. Waldschmidt: "This rate represents a saving of from 4 to 12½ per cent for the average small user. It also helps in the cases of small store rooms. It is the best offer that can be obtained from the Duquesne Light Company and in view of the present economic condition its acceptance is recommended."

A resolution embodying this recommendation, but stating that the Council was not committing itself as to the future, was passed with two dissenting votes. This is the third offer made by the Duquesne Light Company.

Roosevelt Makes Public Utilities a Campaign Issue

POWER, power companies and holding companies landed squarely in the political arena last week when Governor Roosevelt, as Democratic aspirant to the Presidency, outlined his present viewpoints and probable plan for action if elected. Just how much influence these views will have upon the election is highly problematical; election results are ever poor indicators of public opinion on any one topic when many controversial issues are involved.

Power a national problem

"I have strengthened the belief that I have had for a long time, and that I have constantly set forth in my speeches and papers in my work as Governor of the state of New York," said Mr. Roosevelt at Portland, Ore., "that the question of power, of electrical development and distribution is primarily a national problem.

"There has been in the past few years, as the Federal Trade Commission has shown, a systematic, subtle, deliberate and unprincipled campaign of misinformation, of propaganda, and, if I may use the words, of lies and falsehood. The spreading of this information has been bought and paid for by certain great private utility corporations. It has permeated the schools, the editorial columns of newspapers, the activities of political parties, the universities and the printed literature in our book stores.

Regulation for justice to all

"It is an undoubted and undeniable fact that, in our modern American practice, the public service commissions of many states have often failed to live up to the high purpose for which they were created. In many instances their selection has been obtained by the public utility corporations themselves. These corporations have often influenced to the prejudice of the public the actions of public service commissions.

"The regulating commission, my friends, must be a tribune of the people, putting its engineering, accounting, legal resources into the breach for the purpose of getting the facts and doing justice to both the consumers and investors in public utilities. This means positive and active protection of the people against private greed.

"Electricity is no longer a luxury—it is a definite necessity. What prevents our American people taking full advantage of this great economic and human agency? The answer is simple. It is not because we lack undeveloped water power or unclaimed supplies of coal and oil. The reason that we cannot take advantage of our own possibilities is frankly and definitely because many selfish interests in control of light and power industries have not been sufficiently far-sighted to establish rates low enough to encourage widespread public use. The price you pay for your utility service is a determining factor in your use of it. Low prices to the domestic consumer will result in his using far more electrical appliances than he does.

"I am speaking to you as the Governor of a state who for four years has been attacked by the propaganda of certain utility companies as a dangerous man. I have been attacked for pointing out the same plain economic facts that I state here tonight.

Eight points for action

"I seek to protect both the consumer and the investor. To that end I propose and advocate now, as I have proposed and advocated heretofore, the following remedies on the part of the government for the regulation and control of public utilities engaged in the power business and companies and corporations relating thereto:

1. Full publicity as to all capital issues of stocks, bonds and other securities, liabilities and indebtedness, and capital investment, and frequent information as to gross and net earnings.
2. Publicity on stock ownership of stocks and bonds and other securities, including the stock and other interest of all officers and directors.
3. Publicity with respect to all intercompany contracts and services and interchange of power.
4. Regulation and control of holding companies by Federal Power Commission and the same publicity with regard to such holding companies as provided for the operating companies.
5. Co-operation of Federal Power Commission with public utilities commissions of the several states, obtaining information and data pertaining to the regulation and control of such public utilities.
6. Regulation and control of the issue of stocks and bonds and other securities on the principle of prudent investment only.
7. Abolishing by law the reproduction cost theory for rate making and establishing in place of it the actual money, prudent-investment principle as the basis for rate making.
8. Legislation making it a crime to publish or circulate false or deceptive matter relating to public utilities.

Favors private ownership

"I do not hold with those who advocate government ownership or government operation of all utilities. I state to you categorically that as a broad general rule the development of utilities should remain, with certain exceptions, a function for private initiative and private capital.

"Where a community, a city or county or a district is not satisfied with the service rendered or the rates charged by the private utility, it has the undeniable right as one of its functions of government, one of its functions of home rule, to set up, after a fair referendum has been taken, its own governmentally owned and operated service.

"The power issue, where vigorously handled in the public interest, means abundant and cheaper current for American industry, reduced rates and increased use in millions of urban and rural homes, and preservation of our water power resources in co-ordination with flood control, reclamation and irrigation.

"To the people of this country I have but one answer on this subject. Judge me by the enemies I have made. Judge me by the selfish purposes of these utility leaders who have talked of radicalism while they were selling watered stock to the people and using our schools to deceive the coming generation. My policy is as radical as American liberty, as radical as the Constitution of the United States."

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A.S.T.M. Committees Active in Research

Electrical-resistant and insulating materials are to be further investigated by committees of the American Society for Testing Materials, according to recent announcements.

Committee B-4 on electrical-heating, resistance and furnace alloys will investigate in life tests the characteristics of heater units, undertake tensile tests and investigate the creep at elevated

January 1, 1882—**Electric (arc) light companies have sprung up everywhere, and it is found more or less in use in nearly every town. There has been much disagreement of electricians upon the point of whether or not the proximity of heavily charged dynamo-electric light wires to wires used for electrical communication is dangerous to life and property—we hear from eminent authorities that it is perfectly safe to touch electric light wires, or even to touch both wires leading from the machine, one very eminent English telegraph engineer having testified that he has done so.**

—"Electrical World."

temperatures which is permissible in electric-heating apparatus.

More than 25 research projects are under way by Committee D-9 on electrical insulating materials and include studies of: Insulating varnishes, paints and lacquers; molded insulating materials; plates, tubes and rods; insulating mineral oils; solid filling and treating compounds, and insulating papers and fabrics.

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Insull Inquiry Starts; Two Receivers Dropped

Federal investigators from the Department of Justice and Department of Internal Revenue have begun their inquiry into the exceedingly tangled mess that constitutes the residue of the once-proud Insull ventures. Subpœnas were issued calling upon P. J. McEnroe and John F. O'Keefe to testify before Judge Lindley on Thursday of this week. Mr. McEnroe was vice-president of Insull Utility Investments, Inc., and of Corporation Securities Company, both of which Judge Lindley adjudged bankrupt last week. Mr. O'Keefe was secretary-treasurer of both companies and, in addition, was Samuel Insull's confidential secretary.

Samuel Insull, Jr., who was an officer in many of the Insull companies and who was president of Insull Utility Investments, Inc., and of the Corporation Securities Company, sailed for France last Saturday. Mr. Insull, Jr., was to have been subpœnaed to testify on Monday of this week. James Simpson, chairman of the board of the three Chicago operating groups of the Insull system, announced that the younger Mr. Insull was making the trip at his suggestion in order to visit his mother, who is ill, and would be back in November.

Privilege list appears

Names of 205 persons and firms listed in a contract, dated in January, 1929, the terms of which proffered them, according to John A. Swanson, State's Attorney, a total of 250,000 shares of Insull Utilities Investments, Inc., at $12 a share, was made public last week. During 1929 the lowest market quotation for the stock was $30 a share and at its peak it sold for $149.

Upon publication of the names, consisting largely of employees, manufacturers and associates, Judge Lindley removed two Insull receivers, George A. Cooke and Patrick J. Lucey. Their names were on the list. Rumors of other lists and of a wider extension of the subscription privilege persist.

The securities were, it is said, purchased from the corporation before public offering by Samuel Insull, who in turn offered them to those named in the contract. It provided, however, that the purchasers were to hold the stock two and one-half years or else offer to resell it to the corporation at the market price. The document said the persons listed had pledged themselves to purchase the securities.

Corporation Securities audit

The long-awaited receivers' report on the Corporation Securities Company came out last week. Counsel stated:

"It is the conclusion of your receivers that Corporation Securities Company of Chicago is hopelessly insolvent."

There is no inventory of assets. The lawyers explained that the assets were so meager that they could not afford to get an inventory. The report showed a decline of $129,072,618 in the value of the securities held.

Bank loans totaled $15,408,263. There was Samuel Insull's personal note for $5,014,583, signed by him when a New York bank declined to take collateral of an Insull trust alone.

A reform and shake-up of the Illinois Commerce Commission is being asked by the Utility Consumers and Investors' League of Illinois, maintaining that: "The irretrievable injury that has been done the people of this state by the direct losses of hundreds of millions of dollars, the impairment of the financial structure of the many business institutions involved in Insull operations, the wiping out of the surpluses of our local operating companies, demand the adoption of rigorous measures by the state."

Middle West Shake-up

A complete shake-up in the affairs of Middle West Utilities was announced by the receivers on Monday. The entire directorate has resigned and has been replaced by ten directors, all of whom are presidents of leading Middle West subsidiaries. G. C. Neff remains as president of Middle West. Other directors are: C. W. Amiden, Kansas Electric Power; L. B. Harrington, Kentucky Utilities; W. J. Hodgkins, Lake Superior District Power; James C. Kennedy, Central & Southwest Utilities; F. E. Kruesi, Wisconsin Power & Light; John A. Marshall, Great Lakes Power; L. A. Magraw, Central Illinois Public Service; A. W. Moore, City Ice Company, and T. T. Parker, Northwestern Public Service.

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Associated Merger Policies Described to Commission

Routines followed in the acquisition of control of operating companies by the Associated Gas & Electric system were described at the Federal Trade Commission hearing last week. The Associated Gas & Electric Company usually appreciated its investments in these organizations to a figure intended to represent their actual asset value. Charles Nodder, examiner of the commission, testified. Associated was said to have appreciated its investments by approximately $47,000,000 by "writing up" the common-stock holdings of the New York Electric Company, a system company, in six of the seven subsidiary companies controlled by the New York company. He stated, in explaining this transaction, that control of the seven subsidiaries had cost the New York Electric Company $17,183,656, but that the value of the investments was written up to an aggregate of $34,033,580. Outlining the functions of the New York Electric Company, Mr. Nodder stated that it is "no more than a bookkeeping unit of the Associated Gas & Electric system" and that "it has neither employees nor any real organization, but simply a set of account books and supporting papers."

Merchandising activities were discussed before the commission. Examiner Warmack testified that the Associated Utilities Merchandising Company, Inc., was organized during 1928 by the Associated system to take over the sale of appliances, etc., for the entire system. All merchandise held by the New York State Electric & Gas was transferred to the new company. "The paramount feature in this new merchandising arrangement," he declared, "is the fact that the Associated Utilities Merchandising Company received all of the gross profit on the sale of merchandise, while the New York State Electric & Gas Corporation bore all expenses incident to handling, storing, selling and accounting for all merchandising, as well as assumed all losses arising from bad debts, for which no reimbursements or fees were received from the merchandising company."

Improvement Continues, Though Slowly

SLOWLY and painfully economic life in America is struggling to take those first bold steps that presage recovered health. By small but increasingly wider-spread signs are improvements to be noted. Coal and electrical energy are being used in greater volume than is to be accounted for by strictly seasonal trends. Car loadings indicate a continued delivery of manufactured goods in increasing quantities. Steel mill figures rise. Automobile production, however, shows more than seasonal weakness.

General business indexes, where security and commodity prices are involved, show lack of strength, for though rallying smartly last week market prices are distinctly soft and lethargic.

For the long-time view, the inflationist-deflationist problem still stands. Virtually an economic deadlock in world trade will continue until some unity of international trend is established.

Coming Meetings

American Welding Society — Buffalo, N. Y., Oct. 3-7. M. M. Kelly, 29 West 39th St., New York.

National Electric Light Association—Engineering Committees meeting, Edgewater Beach Hotel, Chicago, Ill. Oct. 3-7. A. J. Marshall, 420 Lexington Ave., New York.

National Safety Council—Washington, D. C., Oct. 3-7. W. H. Cameron, 20 N. Wacker Drive, Chicago.

Great Lakes Division, N.E.L.A.—Executive conference, French Lick Springs, Ind., Oct. 6-7. T. C. Polk, 20 N. Wacker Drive, Chicago.

Association of Electragists International—Kansas City, Mo., Oct. 10-12. L. W. Davis, 420 Lexington Ave. New York.

American Institute of Electrical Engineers—Middle Eastern District Meeting, Baltimore, Md., Oct. 10-13. H. H. Henline, 33 West 39th St., New York.

Pacific Coast Division, N.E.L.A.—Engineering section, San Francisco, Oct. 19-20. K. I. Dazey, 447 Sutter St., San Francisco.

National Association of Railroad and Utilities Commissioners—Hot Springs, Ark., Nov. 15-18. James B. Walker, 270 Madison Ave., New York.

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Commercial Values Stressed by I.E.S. at Swampscott

In keeping with the times, economic aspects of electric lighting, progress in equipment design, advances in measurement and co-operation with the architectural and engineering professions featured the 26th annual convention of the Illuminating Engineering Society, held this week at Swampscott, Mass. Elihu Thomson, dean of the General Electric Company's consulting engineers, welcomed more than 200 delegates, predicting far-reaching progress in illumination in the coming years. In response Past-President A. E. Kennelly depicted the vast sweep of electrical progress throughout the world and deprecated political assaults arising from the size of the lighting industry.

President Julius Daniels cited the society's constructive activities under economic handicaps and sounded a vigorous call to further service by co-operation with other industries. Utilities and manufacturers must soon add to their personnel the lighting service specialists dropped during poor times. Both artistic and utilitarian sides of lighting are making notable progress.

At the annual conference of the lighting service committee J. Carl Fisher of Baltimore answered the question "Does lighting service pay?" by a paper indicating that in general lighting load worth $50 a kilowatt may be added at a cost of $20 a kilowatt.

E. A. Brand of Buffalo advocated the sale of adequate wiring in a paper stressing the maintenance of modern electrical service through complete building installations, closer co-operation with architects, contractors and consulting engineers, and placed emphasis on the relatively high cost of wiring changes. Commercial and public buildings promise the best and quickest results in inaugurating lighting bureau service and small buildings offer the most desirable field for central-station departmental activities. The value of department store home-lighting equipment sales to the electrical industry was pointed out by Mrs. Bernice Bowser of New York, who described the Westinghouse department store campaign to be launched this fall on "setting the modern home stage."

Lighting vs. accident and crime costs

Adequate street lighting is capable of saving the country at least $250,000,000 a year in reduced accident and crime costs, according to Prof. F. C. Caldwell of Ohio State University, who discussed this topic at the opening convention session. It is estimated that by properly expending double the present $1.20 annual per capita street lighting costs automobile accidents would be cut 11 per cent and crimes against the person 30 per cent. In discussing this paper Ward Harrison pointed out that street lighting now represents less than 2.5 per cent of the present municipal budget.

An exhaustive paper by L. J. Buttolph of the General Electric Vapor Lamp Company reviewed recent progress in gaseous discharge lamps. Their high efficiency and flexible design stimulate research for improved color quality and simplified operation. The newer low-voltage gaseous conduction arcs are rapidly going into service as high-intensity beacons and floodlights.

Common problems confronting the illuminating engineer and the glass technologist were considered in the report of the joint committee on illuminating glasses, containing test data on reflection, transmission factors and spacing ratios. Many recent developments were listed by W. C. Brown of the committee on progress.

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Manufacturers Should Back the Code, Trumbull Advises N.E.M.A.

"WHILE I have always agreed in the value of a National Electrical Code, I have never realized until this year that it is a vital necessity," President John H. Trumbull told the first policies division meeting of the National Electrical Manufacturers' Association at the annual meeting of the association this week in Rye, N. Y. "I have come during the past year to an intense realization of the need for a single reference standard by which material may be judged to be fit for incorporation in an installation under the code. The growing tendency toward regulation of the sale of electrical material emphasizes this. There must be evolved, by procedure which includes all parties in interest, the requirements which, in the best opinion, are essential to safety. No more than this. There is no warrant for enactment or process in excess of the public safety."

Mr. Trumbull further pointed out that the determination of minimum requirements for safety must be left to some agency at least quasi-public in character. "But one existing organization meets this description—Underwriters' Laboratories. Inevitably I believe there will be general acceptance of the thought, as in the case of the National Electrical Code, that here is the best thing we have for this purpose. Therefore let us adopt it and co-operatively improve it until it meets every need."

That N.E.M.A. might broaden its scope to include as members manufacturers of electrically operated devices was suggested by President Trumbull.

"There is no use going out and using a Polyanna 'Buy-Now' campaign in an effort to persuade every one to increase their purchases of everything," said A. W. Robertson, chairman of President Hoover's rehabilitation committee and of Westinghouse. "The industries manufacturing machinery are down at the heels and rehabilitation in those industries will not only bring about improvements in other industries but will prepare for future needs of the ultimate consumer."

McGraw Award to Swope

On Monday evening the 1932 manufacturers' medal and purse, one of the four James H. McGraw awards, was presented to Gerard Swope for the formulation of the "Swope Plan" for stabilizing employment.

The award was established eight years ago by James H. McGraw, chairman of the board McGraw-Hill Publishing Company, Inc., to encourage constructive thinking for the advancement of the electrical industry. There are four awards, each consisting of a bronze medal and a purse of $100 in gold, and they are given in recognition of the most important personal contribution to progress in several branches of the industry—manufacturing, wholesaling, contractor-dealer and co-operation.

Preparations for united action by electrical manufacturers to take full advantage of any upturn in business were urged at the Tuesday policies session by F. A. Merrick, president Westinghouse Electric & Manufacturing Company, and Gerard Swope, president General Electric Company.

Holding Company Contract Hit by Oregon Commission

Oregon's regulatory commission has ruled that the Northwestern Electric Company is without authority to include as operating expense items of $55,944.06 for the year 1930 and $54,916.16 for 1931 paid to the Electric Bond & Share Company in recognition of certain services alleged to have been rendered to the Oregon utility.

"The Northwestern Electric Company prior to this (Electric Bond & Share Company) contract," reads the order, "was economically and efficiently managed without the aid of the holding company by substantially the same operating force now in charge, and the commission is not justified, and so finds, in permitting the inclusion of the fees in question as a charge to operating expenses and to construction upon which rates for service are based."

The Oregon commissioner holds that there are undoubted instances where holding companies render valuable services to operating companies, but that supervision fees are justified only when services actually needed are rendered, services are valuable to the operating company, charges represent the actual cost of rendering such needed and necessary service and when the charges are no more than would have to be paid elsewhere. "There is no evidence in the record," asserts the commission, "that would warrant a finding that any one of the four requirements had been met."

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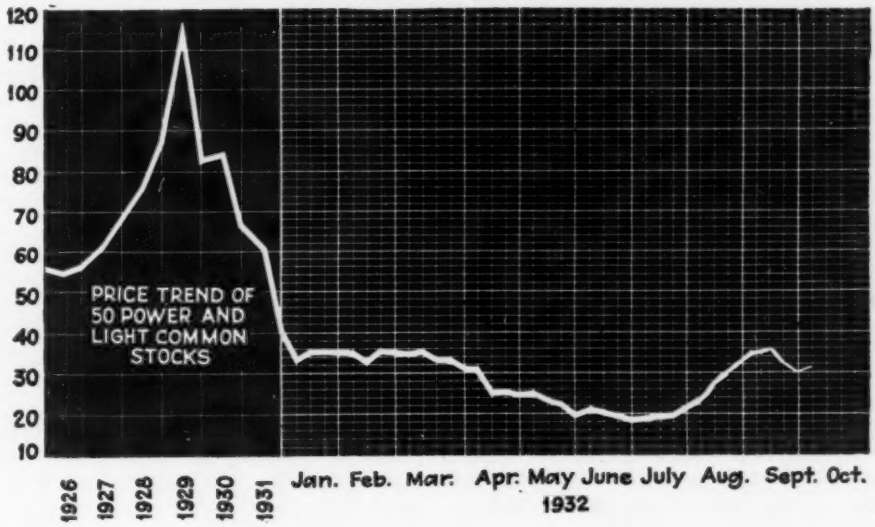
Metropolitan Edison Motion Fought Before Commission

Motion of the Metropolitan Edison Company to dismiss the petition of three minority stockholders for an investigation of the relations between that utility and the Associated Gas & Electric Company (ELECTRICAL WORLD, August 20, 1932, page 229) was argued before the Pennsylvania Public Service Commission last week at a public hearing. Counsel for the company averred that the commission has no jurisdiction over the complaint because it is based on allegations over which only the courts have jurisdiction.

A representative of the three minority stockholders asserted that proceeds of two bond issues, totaling $9,000,000, which were raised to reimburse the company's treasury for casual expenditures and for additions and improvements, were actually used to purchase securities of other subsidiary companies of the Associated Gas & Electric system. He asserted this action was in violation of the company's certification of notification and formed grounds for a commission investigation.

Bonds Irregular; Stocks Advance



Bonds moved irregularly during September, gains being mixed with losses without substantial changes either way. The "Electrical World" index was 93.2 as compared with 93.8 in August. In the past week stocks advanced slightly, from 30.0 to 31.3.

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The city solicitor of Reading was authorized by the commission to file a petition to allow the city of Reading to intervene in the complaint, if it is not dismissed, and if the city believes it to be of vital importance to the city.

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Service Charges in Georgia Under Investigation

Georgia Public Service Commission has fixed November 21 as the date for hearings to begin in Atlanta on the question of abolishing the $1 monthly service charge for electric and gas customers in the state. Chairman James A. Perry, chairman of the commission, stated that both the public, the smallest consumer and the companies serving electricity will be given opportunity to be heard. The original order, directing all power companies to show cause why the service charge should not be discontinued, was directed at the Georgia Power Company, the Georgia Power & Light Company, the Savannah Electric & Power Company and the Washington Water & Light Company.

The resolution stated that there is almost universal dissatisfaction among the consumers of electrical energy on account of the service charge and that this dissatisfaction has been evidenced by thousands of complaints by individuals, groups of individuals, municipalities made to the commission. Approximately 135,000 consumers of electricity will be affected.

Drought Predicted for North Carolina

Based upon flow records from gaging stations on several North Carolina streams and operated co-operatively by the U. S. Geological Survey and the North Carolina Department of Conservation, Charles E. Ray, Jr., chief engineer for the water resources and engineering division of the state department, predicts a severe drought in the eastern part of the state.

According to Mr. Ray, for this area the August stream flow approached and in some instances surpassed previously established minimum values. Rainfall since January has been 19 per cent deficient, and during August was 19 per cent short. Volumetrically speaking, August flow averaged 83 per cent deficient or was only 17 per cent normal. Beginning with January cumulative flow has been 28 per cent deficient. It is apparent that these deficiencies in flow are phenomenal.

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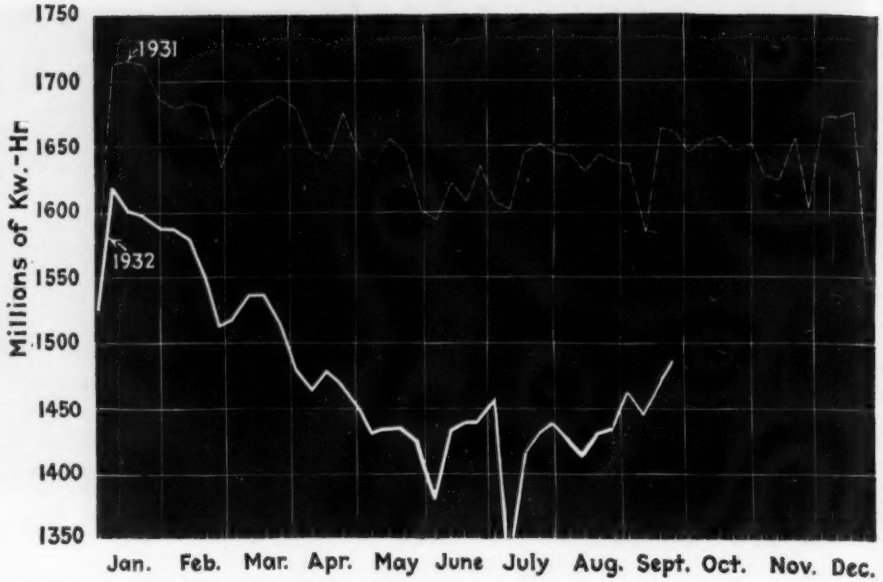
Piqua, Ohio, Proceeds With Municipal Plant

Officials of Piqua, Ohio, where a controversy over the construction of a $675,000 municipal light and power plant has been in progress, have announced that the plant will be constructed and attended formal ceremonies of turning the first shovelful of dirt on the site.

City Manager L. J. Whitney announced that the entire cost of the construction has been financed outside the Ohio teachers' retirement system, which originally had agreed to purchase the negotiable instruments to finance the plant. The opponents of the plant contended that such a source for the fund was illegal. Whitney did not reveal the source of the present funds.

An injunction previously had been secured by the Taxpayers' League to prevent the construction, but Whitney declared that the plans had been filed and contracts signed before the injunction was issued. According to an unconfirmed report construction on the plant proper was started under the supervision of the Monroe Electric Company, Chicago.

Output on the Up-Grade



CONTINUING the rise begun in the middle of August and maintained steadily except as interrupted by Labor Day, electrical energy output of central stations during the week ended September 24 amounted to 1,490,863,000 kw.-hr., according to the National Electric Light Association. This is the largest production in any week since the end of March, and indicates a gain of more than 1 per cent over the week of September 17.

The deficiency compared with 1931 decreased to 10.2 per cent from 11.2 per cent. Last year at this season there was a sharp rise, but it was not maintained. The present up-trend is in marked contrast and appears to be of much greater significance than the widening of the spread from the 8.3 per cent reported a fortnight ago.

Gains were greatest in the central industrial area, smaller on the Atlantic seaboard. The Pacific coast and New England fell back.

Weekly Output, Millions of Kw.-Hr.

Week Ended	1932	1931	1930	1929
September 24	1,491	1,660	1,714	1,778
September 17	1,476	1,663	1,722	1,792
September 10	1,444	1,582	1,727	1,806
September 3	1,465	1,636	1,630	1,675
August 27	1,436	1,638	1,688	1,762

Per Cent Change from 1931

Region	Week Ended Sept. 24	Sept. 17	Sept. 10
Atlantic Seaboard	— 6.9	— 7.3	— 3.8
New England alone	— 6.0	— 4.1	— 3.9
Central industrial	—13.8	—15.3	—13.1
Pacific Coast	— 8.1	— 5.6	— 7.5
United States	—10.2	—11.2	— 8.7

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G.E. Dividends Continued

Directors of the General Electric Company have declared the regular quarterly dividends of 10 cents on the common stock and 15 cents on the special stock.

***January 15, 1882*—Several castles in England now employ the electric light for household illumination and a certain number of houses in the city of New York have subscribed for the light furnished by the Edison Electric Light Company. Since the successful introduction of these lamps, many systems of the same kind have been brought out by different inventors and without speaking of such well-known ones as those of Edison, Swan, Maxim, Lane, Fox, Sawyer, we know of about fifteen inventions bearing more or less on the subject.**

What constitutes Mr. Edison's system is not alone his lamps, it is the totality of the arrangement referring to them and which have achieved such a degree of simplicity that henceforth nothing remains to be desired in practice. This application is being made in a part of the city of New York, where a great number of houses are to be lighted by this system, by means of a subterranean distribution from a central station, from which also motive power will be distributed to the houses. This central station will be provided with twelve steam engines of 150 hp. each actuating dynamo-electric machines, each of which will be capable of supplying, it is said, 2,400 lamps of 8 candle-power.

The current furnished to these lamps comes through a branch taken before each house from the large-sized conductors laid in the streets. These deviations bring the poles of the generator into each house, where the lamp wires can be brought into connection with them, thus rendering each house independent of any other both for supply of light and motive power.

Quite a number of persons come to us and disparage electric lighting. It is certain that new inventions have great difficulty in coming to light and succeeding, above all when they are opposed by rival interests, but when they are really good they triumph in time over all obstacles.
—"Electrical World."

$40,000,000,000 Market Shown by Graybar Survey

That a $40,000,000,000 latent consumer buying power now exists in the United States, only needing improvements in family incomes to develop it, is indicated in the results of a survey among its employees in 73 cities by the Graybar Electric Company.

The survey, based upon the answers received from more than 1,100 employees, shows, according to George E. Cullinan, Graybar vice-president, the largest prospective expenditures to be in the field of general housing needs, approximately one-half of the sum total of $40,000,000,000 being represented in this category alone. Second in deferred demand was automobiles, with indicated demand approximately three times the 1931 rate, while leading the group for electrical equipment were refrigerators with a total estimated demand of more than 8,825,000 units. Ranking next in order were heating equipment, washing machines, radios and ironing machines.

In analyzing the market for non-electrical equipment, the survey showed the need for furniture ranking first in the list of prospective purchases, with rugs and floor coverings taking second place in the intention to buy.

Officials of the Graybar Company point out that their employees, "being electrically minded," propose to buy apparently a substantially greater quantity of electrical appliances than the average citizen because the indicated American market, based upon the questionnaire, is extremely large. The survey indicated the total deferred demand in the United States for the seven leading elements

	Units
New homes	3,096,000
Automobiles	6,006,000
Refrigerators	8,838,000
Heating equipment	1,494,000
Washing machines	4,986,000
Radios	3,708,000
Ironing machines	2,900,000

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Shannon Project Extended

Installation of the fourth unit at the Shannon hydro-electric station near Cork, in the Irish Free State, will soon be made. The new turbine, which is intended to be used for load regulation, is of the Kaplan type and of 30,000 hp. The machines already installed are of the Francis high-speed type. The J. M. Voith Company of Heidenheim, Germany, has been awarded the contract for the new equipment.

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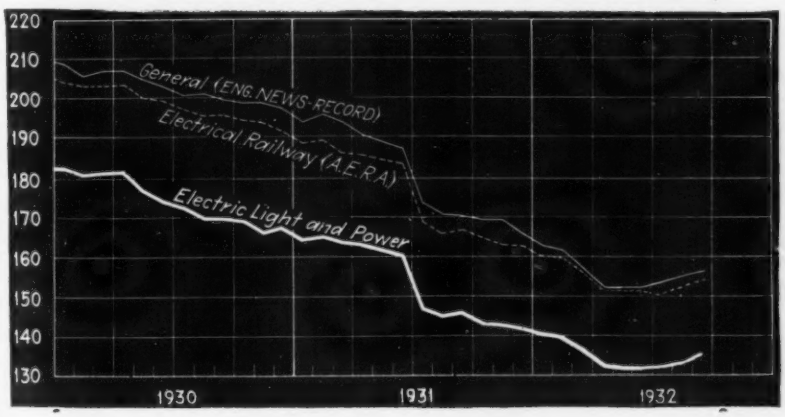
Construction Costs Increasing



CONSTRUCTION costs in the electric light and power industry apparently were at a minimum in June. Since that month the index has been steadily rising, the September figure being 4 per cent above the low point. The change is in harmony with what has been going on in other branches of construction, and indicates a present cost level approximating that of last March.

Last year at this season the curve was still trending downward. The consequence is that whereas in June costs were 18 per cent lower than in 1931 the disparity has been steadily shrinking. It was 11 per cent in July, 9 in August and 7 per cent in September. At this rate the preceding year's costs will be equalled or exceeded by the beginning of 1933.

This index appears in the ELECTRICAL WORLD in the first issue of each month. The entire series, covering a period of nearly twenty years, was published in the February 13, 1932, issue, page 318.

Construction Cost Indices: Electric Light and Power, Electric Railway and General

Base: 1913 = 100

	Electric Light and Power*	Electric Railway*	General—*Engineering News-Record*
September, 1932	136	155	158.0
August, 1932	133	153	156.8
July, 1932	132	150	153.4
June, 1932	131	150	152.2
May, 1932	132	151	152.8
September, 1931	146	167	171.4
Last 5 yrs. high.. Month	184 Apr. '29	206 Nov. '28	210.4 Feb. '29
Last 5 yrs. low... Month	131 June, '32	150 June, '32	152.2 June, '32

*Computed by Albert S. Richey.

Major New Construction This Week

MACHINE DRIVES, heavy-duty motors, transformers and accessories, regulators, electric cranes and conveyors needed by Midcontinent Iron & Steel Corporation, Dallas, Texas, for new mill. Cost $750,000.

Fort Collins, Colo., has voted bonds of $745,000 for a city-owned electric light and power plant and electric distributing system.

Electric-operated pumping machinery, heavy-duty motors and controls, regulators, transformers, conveyors, etc., will be installed in new refinery of Gulf Refining Company, on Staten Island, N. Y., estimated cost $500,000.

Motors and controls, machine drives, regulators, industrial lighting equipment, etc., will be installed at plant of Continental Can Company at Clearing, Ill. Part of a $225,000 program.

Bids will soon be asked by Bureau of Yards and Docks, Navy Department, Washington, D. C., for power plant equipment — at Brooklyn, N. Y., $565,000; Mare Island, Calif. $325,000; Portsmouth, N. H., $250,000; Keyport, Wash., $57,000; Boston, Mass., $50,000; St. Juliens Creek, Va., $90,000; Puget Sound, Wash., Navy Yard, $15,000.

Electric-operated pumping machinery and motors and controls will be installed in oil storage and distributing plant of Great Western Oil Company, Cleveland, Ohio. A $500,000 project.

Lower-Priced Refrigerator Offered by General Electric

Formal announcement of a low-priced secondary line of electric refrigerators of conventional design has been made by the General Electric Company.

Coincidental with the introduction of the new model, P. B. Zimmerman, manager of the electric refrigeration department, announced that sales and advertising efforts will continue to be concentrated upon the hermetically sealed monitor top refrigerator placed on the market five years ago. Beginning in October the General Electric line will be composed of three sizes, a small machine with a capacity of 4 cu.ft., a medium-sized model with 5 cu.ft. capacity and a 7-ft. model. A nation-wide advertising campaign is to be launched. List price on the 5-ft. General Electric Junior is $135.

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New York Metal Prices

	Sept. 20, 1932 Cents per Pound	Sept. 27, 1932 Cents per Pound
Copper, electrolytic	6.25	6.25
Lead, Am. S. & R. price	3.50	3.15
Antimony	5.62½	5.625
Nickel ingot	35.00	35.00
Zinc, spot	3.70	3.60
Tin, Straits	24.30	24.70
Aluminum, 99 per cent	23.30	23.30

General Water Works to Reorganize

Following the announcement of C. A. Davis, vice-president of the General Water Works & Electric Corporation, that the company, being unable to pay interest due October 1 on the 1944 series of debentures, has gone into receivership, the readjustment committee headed by Wiley F. Corl made public a reorganization plan with which the receivership proceedings will not interfere. The plan involves the organization of a new company under the laws of Delaware, called the General Water, Gas & Electric Company, which will acquire the assets of the present company through an exchange of shares.

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Iowa Refrigeration Survey

That 96,000 able-to-buy families living in wired houses in Iowa view an electric refrigerator as their next major household appliance purchase is indicated in the conclusions drawn from a survey just completed by the Des Moines *Register and Tribune*. There are 398,000 domestic electric consumers in that state.

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Date Extended for Stock Exchange

California Railroad Commission has granted application of the Pacific Gas & Electric Company to extend until March 31, 1933, the period in which to exchange its preferred shares for those of the Great Western Power Company of California.

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An All-Welded Pipe Line

Southern Fuel Company of Los Angeles, Cal., has constructed an all-welded 26-in. steel pipe line from Kettleman Hills to Long Beach, Cal., a distance of 207 miles, to supply natural gas to the Southern California Edison Company for use in its steam plant at Long Beach and for distributing companies. Western Pipe & Steel Company of California fabricated 76 miles of the pipe used on this line at its Los Angeles plant. The pipe was formed from flat plate, which was crimped at the edge in the usual manner, formed on bending rolls and then transferred to automatic arc-welding machines where 30-ft. longitudinal seams were welded. Pairs of 30-ft. sections were welded into 60-ft. lengths and in this form shipped to the field location to be welded into a continuous line. The system is designed for an initial pressure of 400 lb. and a minimum pressure, at the extreme southern terminus, of 50 lb.

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Gary-Midland Investigation

Relations between the Gary Heat, Light & Water Company, the Gary Electric & Gas Company and the Midland United Company will be investigated by the Indiana Public Service Commission (ELECTRICAL WORLD, September 17, page 360). The commission has also ordered that the Gary operating utility be prohibited from issuing, selling or disposing of any further securities until the further order of the commission.

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Stone & Webster Pays Off Bank Loans

Stone & Webster, Inc., paid off all its own bank loans during the first eight months of this year. Its principal subsidiary, the Engineers Public Service Company, reduced its own and subsidiaries' bank loans by $3,720,000 during the same period. Other Stone & Webster subsidiaries reduced bank loans by $600,000, making total reductions of $6,220,000 by the group so far this year. To effect this decrease in indebtedness cash was cut only $1,040,000, from $8,250,000 as of December 31, 1931, to $7,210,000 as of August 31, 1932.

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Municipal Plant for Fort Collins

Fort Collins, Colo., served by the Public Service Company of Colorado, has voted to amend the city charter authorizing and ordering the city commission to acquire a municipally owned electric power plant and distribution system. Bonds for this purpose, to the amount of $745,000, are to be issued.

Electricity in Stock Yards

In the abattoirs at Lyons, France, an electrical device consisting of a set of electrodes in the form of a light helmet is used to shock swine into insensibility during slaughtering. Advantages of the device include the reduction of the risk of the swine becoming violent and out of control during the killing. It is pointed out that suffering by the animal is practically eliminated and that the brain remains intact. The cost of the electrical energy necessary to operate the device is said to be negligible and the apparatus itself, which is simple in construction, can be used almost indefinitely. It has not been used on larger animals.

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Soldering Lugs Standardized

As the result of five years' effort to develop a standardization for soldering lugs the N.E.L.A.-N.E.M.A. joint committee specifications for terminal lugs have been accepted by all interested parties. These are electrical apparatus, overhead system and underground systems committees of N.E.L.A. and codes and standards group of N.E.M.A. Both standard duty and heavy-duty lugs have been covered. Diameters and spacings of bolt holes are the same for all sizes from 250,000 to 2,000,000 circ.mil.

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Boilers to Deliver 835-Deg. Steam

Two steam-generating units, each capable of producing 375,000 lb. of steam per hour at about 720 lb. gage and 835 deg. F., have been purchased from the Babcock & Wilcox Company for the new Buzzard Point station of the Potomac Electric Power Company. The arrangement of this equipment will, it is said, mark a forward step in design in relation to compactness of plant, accessibility and features to insure cleanliness in the station, together with the avoidance of fly ash discharge from the stacks. The Stone & Webster Engineering Corporation is the designing and constructing engineer for this development.

***May 1, 1882*—A very important monopoly, the fact of which has just leaked out, was created March 22, in the consolidation of the Edison Electric Light Company and the Gramme Electrical Company. The Gramme combination was formed about a year ago and comprised the American Electric Company of New Britain, Conn.; the Brush Electric Company, the Fuller Electrical Company, the Jablochkoff Electric Lighting Company, the United States Electric Lighting Company and the Weston Electric Light Company.**

Major S. B. Eaton, vice-president of the Edison company, speaking on the matter, says: "We do not use the Gramme machine, the Edison machine in no sense whatever infringes on the Gramme patents. Our reasons for joining the Gramme company had nothing to do with Gramme patents. We desired to avail ourselves of the advantages of a business organization controlled by people engaged in enterprises similar to ours, and united to promote harmony, uniformity of prices and simplicity of litigation, and also to prevent the public from being imposed upon by new companies without patents and without integrity. Such companies spring up daily. It is one of the functions of the Gramme company to strangle all such organizations, and we would gladly join the Gramme company just for that convenience of having some one else take off our hands the tiresome and expensive task of putting so many other combinations to death. The Edison company is devoted exclusively to incandescent lighting and all of the other companies composing the Gramme combinations are, with a single exception, devoted exclusively to arc lighting."—"Electrical World."

Sodium-Filled Pipes Better Conductors Than Copper, Electrochemists Hear

ELECTROPLATING, photo-electric cells and electro-organic chemistry were the fields to which attention was devoted at the three-day convention of the Electrochemical Society in Cleveland last week. Of prominent interest to electrical engineers was the report on sodium-filled pipes used as conductors for heavy currents at the Dow Chemical Company plant at Midland, Mich. The distribution involves from 500 to 4,000 amp. and has been in commercial service since the beginning of 1931.

A line 840 ft. long consists of two conductors made of 4-in. standard iron pipe filled with metallic sodium. Cost comparisons revealed that a four-conductor, 1,000,000-circ.mil copper circuit in place on poles had cost $5.39 per foot, whereas the sodium-pipe conductors on racks had cost $4.92 per foot, the latter figure including, of course, the cost of the sodium metal. Preliminary estimates made in 1927 had indicated that sodium would be a less expensive material than copper for electrical conduction if its cost per pound were less than three times that of copper. It has three time as high a specific resistance, but, on the other hand, it weighs only one-ninth as much as copper.

The experiment has proved that sodium could "compete with copper as an electrical conductor even with copper at its present low cost if it were possible to buy sodium-filled iron pipe direct from a manufacturer for the cost of the sodium plus the cost of the pipe. Its use would of course be limited to permanent installations where high currents at relatively low voltages were to be transmitted."

In connection with zinc plating a study of zinc and zinc alloy anodes in both acid and cyanide electrolytes has disclosed that a zinc alloy anode with 0.5 per cent aluminum and 0.3 per cent mercury is preferable to the ordinary amalgamated anode.

Photo-cell developments

Attention was given in the photo-electricity discussion to the characteristics of several types of photo cells. A cæsium-oxygen-silver cell has been obtained which is highly sensitive to red and infra-red. The maximum response is at 8,000 Angstroms; it is one-third as great at 10,000 and the threshold is near 12,000. Sensitivity is of the order of 35 microamperes per lumen at 2,710 deg. K. A titanium cell has been used to determine the erythemal strengths of the many types of mercury discharge lamps which have come on the market with the rise of the ultraviolet fetish. This cell has advantages for this work because it begins to be sensitive at 3,150 Angstroms, the upper intercept of the accepted erythemal curve. It also has higher sensitivity than the uranium cell in the 2,500-2,800 Angstrom range.

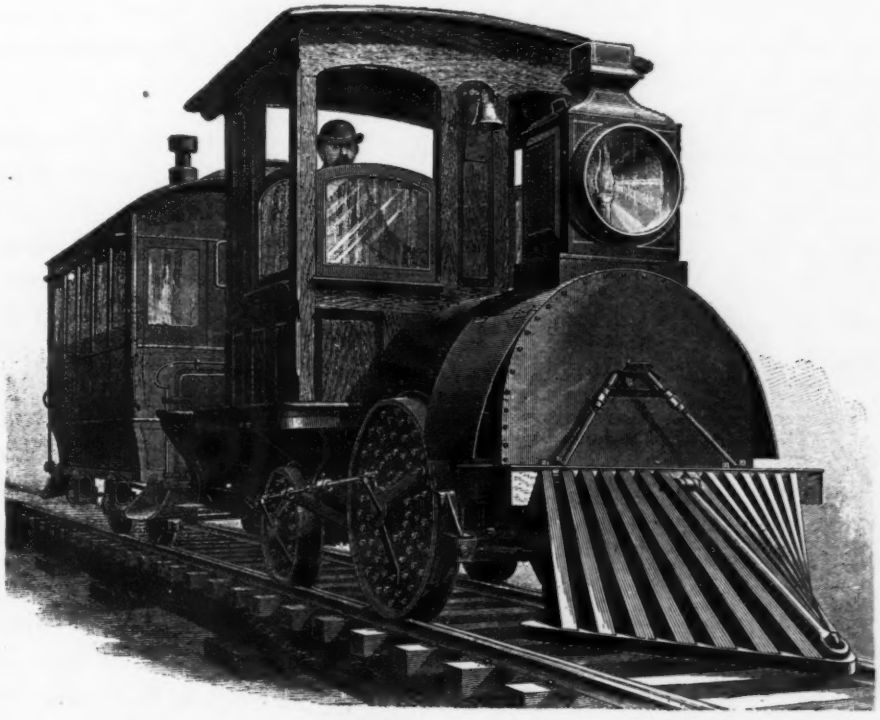
A chrom-selenium cell has been devised in commercial form with a sensitivity of about 150 microamperes per lumen and a maximum response at 5,100 Angstrom units. This Cr-Se film is reported to be more uniform and stable in operation than straight selenium cells and also allows better manufacturing control of the characteristics of cells of high photo-sensitivity.

Technical data on the air-depolarized primary cell developed by the National Carbon Company for A-supply to rural radio sets was conveyed in one of the papers. A carbon cathode "breathes" from the atmosphere the oxygen required to prevent polarization of the cell in operation. Caustic soda is the electrolyte and the anode is amalgamated zinc. Open circuit voltage in the two-cell battery is 2.8 to 2.9 volts and this falls initially to 2.45 volts with draughts up to 0.65 amp. For 600 amp.-hour withdrawal at this rate the voltage will have fallen to about 2.1 volts and exhaustion occurs at between 700 and 800 amp.-hours. This capacity adapts it to a year's life on three hours use per day of prevailing radio sets. These air cells are shipped dry, the porous cathode sealed with cellophane and the vent sealed by a readily puncturable diaphragm. Filling with water makes it ready for use after fifteen to 30 minutes to complete solution of the caustic. The new battery opens to the radio market the unwired rural homes where only storage batteries or dry cells have heretofore been available for A-power.

Hoover Dam interests few

An informal conference attended by a large number of the members disclosed that no strong tendency exists at present for electrochemical industries to grasp the power opportunities offered at Hoover Dam beyond the commitments already made for that power. Climate, limitations of competitive transportation and distance from market seem to offset the attractiveness of the joint availability of many raw materials and relatively cheap power. No formal action was taken toward anticipating expected overtures from government quarters aimed toward electrochemical absorption of the power.

MR. EDISON'S ELECTRIC RAILWAY PROGRESSES



February 10, 1883—**Mr. Edison stated: "It is doing well. I had it running from a point on the Pennsylvania Railroad to Metuchen, a distance of 2½ miles. The locomotive runs at the rate of 29 miles an hour with one passenger car containing 40 passengers."—"Electrical World."**
[The trucks of this locomotive are now mounted outside Mr. Edison's West Orange laboratory.]

THE ELECTRICAL WORLD

L. W. W. MORROW, Editor

New York, October 1, 1932

AN OUTLOOK AND A PLAN

Fifty years have passed since the first Edison dynamo in the Pearl Street station started an era of change and growth unparalleled in history. The age of electric power and machines was then and there thrust upon an incredulous world and the hum of the first generator has become the roar of the machine age. Where is the next half century to take us? Does the present economic breakdown presage the destruction of this civilization through the unleashing of unbalanced and uncontrollable forces or can we go forward by shaking the cornucopia of science and engineering to endow mankind with even more agencies that eliminate toil, increase comfort, amplify production and facilitate transportation and communication? We believe we can go forward. We believe the electrical industry holds within itself the major elements necessary to advance the comfort and prosperity of the human race, which is the only true yardstick by which to measure progress.

Progress Can Be Made

We know that the electrical industry is still in an early phase of its dynamic existence. Electrical science is still fertile; invention and engineering already point to faster technological progress; markets for electrical products and services are either unserved or unsaturated. There will be more uses, new uses, lower costs, higher efficiencies, increased safety and a greater weaving of electricity into the social and industrial fabric of the nation. It is possible to harness and control this scientific giant and make him an intelligent as well as a powerful servant.

But we know also that the future of the electrical industry as well as that of all industry depends upon the ability of national leaders to solve the social and economic problems of the present and the future, introduced by the revolutionary changes in the life and activities of the mass of mankind brought about by past applications of scientific and engineering developments. The electrical industry will prosper only if the country prospers, and, further, we believe the electrical industry can play a major part in the thought and action needed to improve the national welfare. Thus, the greatest opportunities as well as the hardest problems confronting the electrical industry are external and not internal. They are linked with all the activities of our present civilization and necessitate the rigorous application of new economic and social principles and practices. Only by doing this is it possible to maintain the capitalistic system and private initiative against the destructive attacks of the communistic system with its national socialization program. It is necessary to prove that the machine age indisputably advances the whole status of mankind.

Internal Changes Are Necessary

Undoubtedly the experiences gained in the past fifty years, and especially those of the last three years, point out the need for changes in the internal policies and practices of the electrical industry. It is evident that all the activities of the utilities must be open to public inspection. Management must have higher efficiency and more integrity to avoid the assumption of management functions by regulatory authorities. The place and functions of the holding company must be defined more clearly and corporate structures must be simplified to eliminate pyramided organizations. A decentralization policy must be adopted whereby local management is given power and responsibility and territorial holdings must be adjusted to logical economic areas that result in the lowest costs and the best service. Utility securities must become more stable and meritorious in the opinion of conservative investors in order that the industry may secure the primary capital necessary to its expansion program.

Managers must become more professional. They must better balance their organizations and their activities between public relations, sales, engineering and accounting so that the development of the territory served is accomplished under conditions that produce

both favorable public sentiment and favorable investor sentiment. In the light of the recent wide fluctuations in dollar values and security values it will be necessary to introduce more conservative financial policies whereby there is less borrowed capital, a faster rate of write-off of investment and a larger accumulation of liquid reserves. It may be necessary to forget past practices and consider the distribution system to extend into the interior of homes and factories and to own and operate all power production plants. Whatever is economical and logical must be done, unhampered by past practices, in order that rapid progress may be made.

Electrical manufacturers, jobbers and retail outlets for electrical goods also must measure up to new conditions and eliminate traditional wastes and costs. It is necessary to change the business mechanism for both production and distribution. In order to compete for the dollars of buyers there must be greater co-operation between industry branches, and this must take the form of practical business activities.

All these internal industry changes reduce to essential acts to bring about cost reductions, sales expansion and higher managerial efficiency. Action is being had already to do these things, and industry leaders, as shown by the articles in this issue, have a clear understanding of the opportunities that exist for improving the status of the industry.

Prove Worth of the American Idea

In its external relations and activities, however, the industry must focus its efforts both to expand its markets and to contribute its quota of thought and action for the maintenance of American ideas. Unless all industrial leaders appreciate the gravity of present conditions and the serious nature of present destructive trends and act constructively there is little doubt that the mass of the people will seek political solutions of their problems. This program would be ineffective in the end, but it would meanwhile destroy progress through the adoption of socialistic and communistic schemes. At no time in history has there been more need for clear thinking and direct action by business leaders, and utility executives especially should respond to the call for action. Their industry would be the first attacked and they are especially linked to community building in all its diversified aspects through the service they render. They should assert leadership and help co-ordinate the thought and action of their customers to secure better conditions.

Not a Time for Panaceas

The solutions to present national problems do not rest solely in the adoption of shorter working hours, shorter working days and shorter working weeks. They do not lie in a socialistic program of governmental control and operation of all industry. They do not lie in inflation or deflation, in stock market regulation or in increased bank credit. Present dislocations and unbalances are serious and remedies must be more potent than inflation policies. There must be less blind faith that previous conditions will return. Losses must be incurred, changes must be made, habits and customs must be modified to conform to very different social and economic standards. Our problems can be solved and conditions improved by intelligent planning and action and this requires positive action and a gradual shift over a period of years. Here is the opportunity for electrical leadership.

Concentration and Specialization Questioned

Undoubtedly the leaders of industry to date have been production - minded. They have made mass production their objective and have taken little account of consumption. They have not applied the principle that the more there is produced the more money or credit—purchasing power—must be placed in the hands of the masses. They have forgotten that production efficiency is measured from raw material to ultimate consumer and not from raw material to the loading platform of factories or farms. In our system the mass must draw dividends from prosperity upon some basis of equality with capital accumulation or investments in productive capacity will ultimately crash of their own weight. Future business enterprises must move goods from machines to consumers and business merit will be measured by the degree of effective maintenance of consumer-purchasing power on a plane of equality with the maintenance of plant production machinery.

Future ideas of capital, credit and wealth must be based on the knowledge that investment conditions are transitory, that economic life is short and that goods and services in current commerce make the best indicators of wealth. Credit obligations will be based upon shorter terms and the aim of business enterprise will be capital turnover and not capital accumulation. Moreover, there must be more social-minded executives who measure success in terms of human welfare as well as profit. What definite things

need to be done and can be done? One principle to apply that offers prospects of success is decentralization. Thought and action to carry out this principle should be applied to each market area as well as to the nation.

Decentralization means merely the building up of self-sustaining areas that incorporate both production and consumption for all community needs. This gains the cost of transportation and a saving in time by putting goods and consumers in close proximity. To carry out this principle many industries must relocate their plants and their workers or establish branch plants. The day is past for a single mass production plant to supply the national market with even a single product or service. Labor must diversify so that it can work part of the time in factories and part of the time on farms or at other occupations. The O. D. Young suggestion of a worker with a house, garden, cow, chickens and pig, whereby he works in a factory part of the time and at home part of the time, can be practiced.

Decentralization means that the economic validity of the large city will be challenged. It means that mass production enterprises for supplying all areas with either manufactured or farm products will be successful only as they can capitalize transportation differential costs or possess unusual local economic advantages. The principle of decentralization, the development of self-sustaining communities and the diversification of industry and of workers—these steps are now economic and practical if intelligently planned and controlled. The broader and more definite applications of these ideas offer the greatest opportunities for cost reductions, the balancing of production and consumption and the continuous maintenance and even increase of consumer-purchasing power. As desires and needs increase in a community, they are satisfied by an increase in the local production facilities, and both production and consumption grow with an increase in population and in the purchasing powers of the inhabitants.

A very practical aspect of the application of these ideas is that the rate at which each area is made self-sustaining and self-contained should be measured by the maintenance at all times of maximum prosperity for the people in the area. Labor turnover or unemployment is a very direct gage whereby the rate of change can be determined. Also, with investors now more rigid in their requirement that capital be written off at a more rapid rate, undoubtedly human labor gains a cost differential against the machine that will continue during the next few years, and this makes the changeover and readjustment program even more feasible, especially in manufacturing areas.

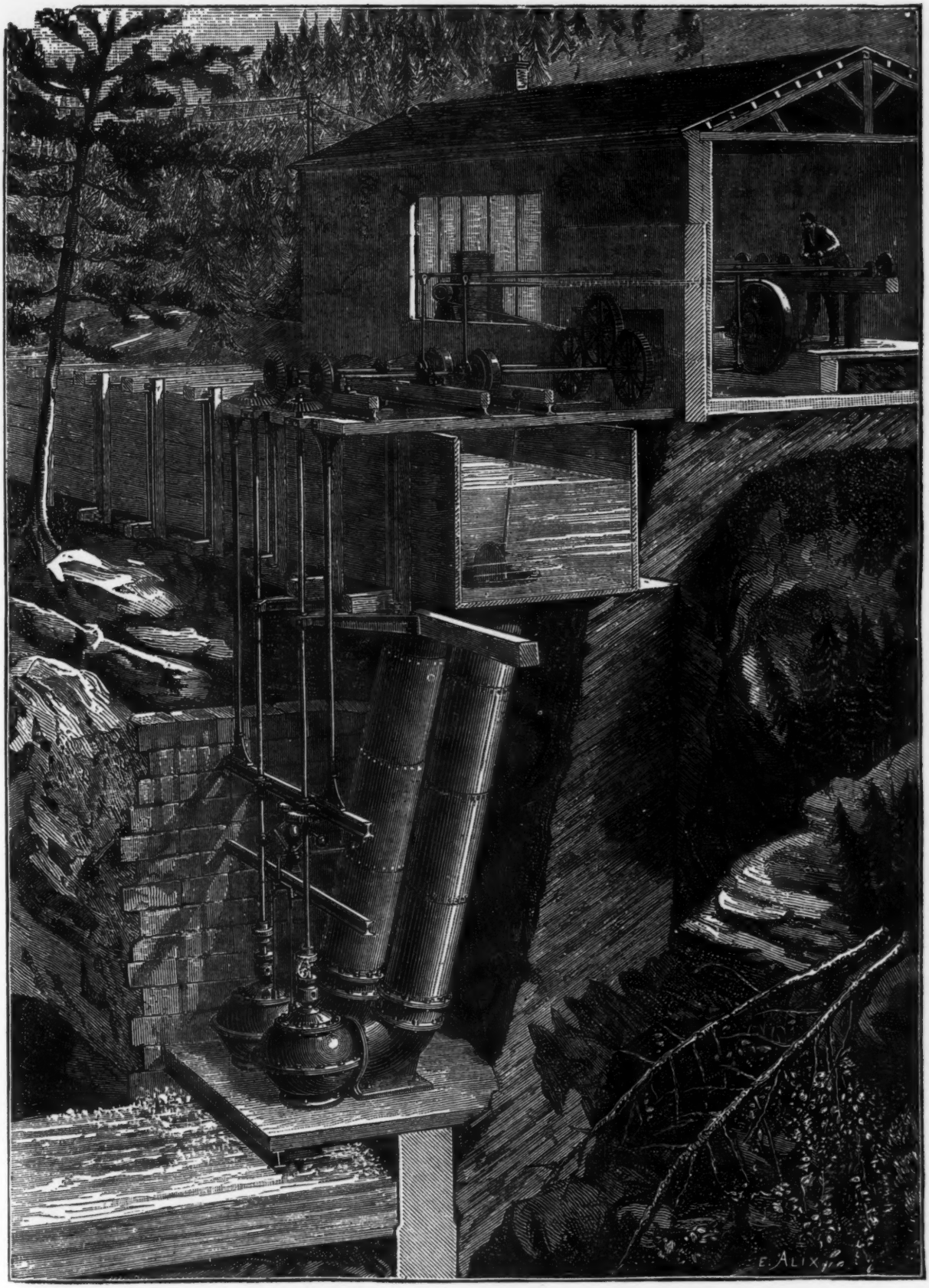
New England Is an Example

Evidence of the economic validity of these principles is found in New England. This region suffered less than any other in this period. It is almost self-sustaining in production and consumption, with small diversified industries and small diversified farms. Through the efficient planning and action of the New England Council unity has been had in maintaining prosperity and contentment in the region during these trying times, but underlying this was the decentralization and self-sustaining characteristics of the territory. Undoubtedly there must be less concentration and specialization and more decentralization and diversification in all areas.

Economic and Social Leadership

Utility leaders can help apply these principles and ideas. Their service areas have been built up as to territorial extent on these economic principles. They serve all industry and all workers in their areas. They will grow as their communities grow and they have every incentive for taking leadership in planning and bringing about the local changes that will secure continuous and balanced prosperity for all. This is the big opportunity for service and this is the necessary field of action for utility executives if they wish to advance their own interests and those of the people in the communities they serve.

We believe man needs and is prepared for the bounties of science. We believe he has the ability to use his scientific endowments to advance his prosperity and welfare. We believe the present period is constructive in that it has brought experience and thought to bear so that balance and control will come into action whereby future progress will be more stable and more rapid. We believe much of the present pessimism comes both from a lack of perspective of the forces that have brought about disturbing trends and an absence of an understanding of the revolutionary changes necessary to balance the mechanistic economic and social elements of modern civilization. We believe that through adversity and experience comes the courage, the wisdom and the patience necessary to make better and greater progress in the future. Now is the time for the electrical industry to capitalize upon fifty years of progress and experience.



An Early Hydro-Electric Station

Turbines used in the station of the Portrush (Ireland) electric railway

"Electrical World," May 17, 1884

Pioneers' Zeal and Integrity Again Needed for Next Era

By WILLIAM S. BARSTOW
President Edison Pioneers, New York

PROMPTLY after Mr. Edison had invented the first practical incandescent lamp (October 21, 1879) and the tall magnet bipolar dynamos he made several complete isolated installations. The pioneer commercial plant was on the *S.S. Columbia,* plying between San Francisco, Calif., and Portland, Ore. The first Edison "land" plant was on the premises of Hinds, Ketcham & Company, printers, New York City, January, 1881, and others followed.

Prior to this time Mr. Edison decided to develop and install a complete central-station system. He said later:

> As I had to compete with the gas system, it had to be commercially efficient and economical. The network of conductors must be fed from many different points and must be capable of being tapped anywhere. I had to devise a system of metering and the meters must be accurate so that we could charge correctly for the current used. Means had to be devised for maintaining an even voltage on the network; the burning out or breaking of lamps must not affect other lamps and there must be no violent fluctuations of current. One of my largest problems was to build dynamos more efficient and larger than any heretofore made, and I had to make their internal resistance small, so that I could get at least 90 per cent of salable energy. Of course I had many details to work out, such as switching gear, lamp holders, chandeliers and whatever was necessary to provide so that the system could compete with gas. Why did I fix 110 volts? I based my judgment on the best I thought we could do in the matter of reducing the cost of copper and overcome the difficulty we had in making the lamp filament stable at high voltages.

The strenuous work of developing the Edison system began in 1878, and on completion of all preparations the Edison central-station system was a practical working success from the very start. All possible types of dynamos had been considered, especially disk machines and armatures with disk cross-connections, the "Jumbo" machines with horizontal fields being of this construction. These giant dynamos were direct driven at 350 revolutions by single-cylinder engines of 200 indicated horsepower, the combined unit weighing 30 tons.

The first commercial central station in this country was put in operation at 255-257 Pearl Street, New York, September 4, 1882, and distributed current over a two-wire underground network of conductors. The initial central three-wire station was started at Sunbury, Pa., July 4, 1883, and Brockton, Mass., was the first to use three-wire underground conductors October 1, 1883. The first Edison "Jumbo" was sent abroad and operated at the Paris International Exposition in October, 1881. The second "Jumbo" was started at the Holburn viaduct station, London, England, January 12, 1882, and a second machine on April 8, 1882, the station operating regularly after April 11, 1882.

The old Pearl Street station was the first attempt of the Edison Electric Illuminating Company of New York to supply the public. It started with a load of 400 16-cp. lamps in 59 buildings wired for 2,300 lamps, serving through a complete underground system, with a total length of 18 miles of feeders and mains, the district supplied covering a square mile. There were six "Jumbo" horizontal dynamos installed, each having a maximum capacity of 1,200 16-cp. lamps of 110 volts and 0.75 amp. each.

The station was started on a lamp bank of 1,000 16-cp. lamps. There were no instruments available. A 16-cp. lamp of 110 volts operated by batteries was the standard of illumination and the pilot lamps of the dynamo by means of dynamo field boxes were kept by eye as close to this standard as possible. It was found that no difficulty was experienced with one dynamo, but when the second dynamo was connected (when the pilot lamp was of the same approximate voltage as the standard battery lamp) there developed serious trouble. The load would swing from one dynamo to the other, despite the frantic efforts of the "dynamo tender" to adjust the copper brushes, from which issued plenty of "fireworks."* One day Mr. Sims of the Armington & Sims Engine Company visited Mr. Edison, who was on constant duty at the plant, and they both decided that the swinging load was caused by the oversensitive Porter

**Information through courtesy H. A. Campbell, Edison Pioneer, New York Edison Company, who was present at starting of station.*

***July 1, 1882*—Wonderful as has been the development of the telegraph, it appears that ere long we shall look upon it as but one, and by no means the most marvellous, of countless applications of electricity. We seem to have discovered a giant whose powers are illimitable, yet whose strength can be applied to do the most delicate and subtle work—who is always ready for duty, and whose energies can be drawn out in a thousand ways—whose strength can be generated at one place and carried to another for use, without serious loss—who will begin working and stop working at a touch.**

Allen governors. This was found to be the case and the original 125-hp. Porter Allen engines were removed, Armington & Sims engines substituted and the difficulty was overcome.

The underground conductors were of large size copper rods of half-moon section, 20½ ft. long. These rods were wound with rope to separate them and forced into a 20-ft. wrought-iron pipe. Asphaltic compound was then forced in and filled the spaces between the pipe and conductors. A rubber plug drilled so that the copper conductors protruded was driven in the ends of the pipe and sealed in "the compound." This was the Kruesi tube and, when joined together by flexible soldered "joints" and "a coupling box" filled with compound, was the basis of the underground feeder and distributing system. The feeders extended from the station not to exceed ½ mile to "junction boxes," from which radiated the interconnected mains.

Street short circuits were frequent and often shut down the plant and attracted the public with hot paving stones and smoke.

Even when these difficulties were minimized, there remained the house system troubles. There were no rubber-covered conductors, all wiring being done with Underwriters' (or, as then termed, "Undertakers") wire. This was bare copper wire covered with two layers of cotton braid painted with white lead. The two conductors were fastened to ceiling or side walls by wooden cleats. Fuses were introduced frequently, at top of fixtures and wherever thought necessary, and were fastened to wooden blocks (or rosettes).

Conductors were wrapped around the gas fixtures and continued to the gas burner, where "an attachment" was put below the burner and to this was fastened a wooden socket, the inside of which was lined with brass to accommodate the screw base of the incandescent lamp. Later grooved wooden molding was used to inclose the conductors for sake of appearance, but the cotton-covered wires laid in the molding and covered with a cap started many fires, so that the cleat installation was considered safer. The 16-cp. lamps (82½ watts each) were of large size glass elongated bulbs, containing the U-shaped carbon filament. The curious public little thought as it viewed "the little red hairpins in the glass bottles" that it was witnessing the beginning of an industry which would embrace the world, nor was it aware of the struggles of the unseen inventor and his associates in solving ever-occurring problems. Time and again "the old man" was called upon to meet a trying situation, but his vision, inspiration and "perspiration" always triumphed. The demand for electric service increased steadily and, as the current could only be distributed approximately one mile from the station, it soon became necessary to build "an annex." This was located at 60 Liberty Street in 1886.

The influence of the electric light upon the sight is a subject likely to attract attention. Numerous observations lead to the conclusion that there is nothing prejudicial in the nature of the rays derived from the electric light, but, on the other hand, this light may be of great benefit by reason of its superior illuminating power. In the not far distant days of electric house illumination the companies may be trusted, if only for the sake of their own pockets, not to do serious injury to the general public by an excessive supply of light. We must remember that electric lighting is still in its infancy.—"Electrical World."

- Incandescent lamp was only forerunner to solution of many problems.
- Voltage regulator, parallel operation, underground mains and metering presented obstinate obstacles.
- Household wiring devices and fixtures had to be developed from zero.
- Low load factors demanded development of motor loads.
- Holding company and state regulation date back to early days.
- Edison Association formed to disseminate operating knowledge.
- Fortitude and conscientiousness of the pioneer days again needed to insure sound progress in the next decades.

By this time the industry was well started. The Edison Electric Light Company handled Mr. Edison's patents, did the engineering and made the "determinations"; i.e., the probable consumption of each house, store, etc., was carefully plotted in figuring the size of feeders and mains. The Edison Machine Works built the dynamos. The Edison Lamp Company manufactured the lamps. The Edison Tube Works made the Edison underground system, and S. Bergmann & Company manufactured all house appliances, sockets, cut-outs, etc., and later, when invented, station instruments. Under the Edison patents the Edison Electric Light Company licensed one local company in each community. Each company was obliged to prove its financial resources before it could secure a license, and to pay for this right to use the complete Edison system one-third of its capital stock as issued at the time and as issued thereafter. As patents expired this percentage was gradually reduced. A licensed local company was named "Edison Electric Illuminating Company of ———."

In the early part of 1885 James S. Humbird, general agent of the Edison Electric Light Company for the state of Pennsylvania, requested the representatives of the different Edison Electric Illuminating Companies to meet in Harrisburg for a general conference. The meeting was held April 15, 1885, and there were present representatives of five companies: H. K. Wood, Piqua, Ohio; Westley Auten and Frank S. Marr, Sunbury, Pa.; William S. Schwenck, T. M. Righter, Mount Carmel; Samuel Insull, F. S. Hastings, H. M. Doubleday and Francis R. Upton, New York, and James S. Humbird, Cumberland, Md.

Mr. Humbird stated:

> the object of the meeting to be an interchange of opinions among those interested in the electric lighting business, in order to elicit all the information possible for the purpose of advancing their mutual interests.

The different views expressed and the experience of those present showed that, now that the industry had settled down to a practical basis, the difficulties were mainly due to lack of knowledge of how to operate rather than from defects in apparatus or installation. At this meeting, on motion of H. K. Wood, an associa-

August 1, 1882.—**The following circular letter was sent last week to every householder or tenant in the First District of the Edison Electric Light Company, that bounded by Spruce, Nassau and Wall Streets and East River: "We are rapidly approaching the completion of our central station, from which you will be supplied with Edison light, our street conductors are now laid, and it will be necessary, in order to supply you with the light when we are ready, to connect your building with them. The station in Pearl Street, near Fulton Street with its enormous dynamos, machinery and boilers is completely finished and ready to begin at once. The mains are laid throughout the district and all the houses are wired ready for the lamps.**

"The factory of the Edison Electric Lamp Company has been moved from Menlo Park to East Newark, N. J. Up to April 1, 80,000 lamps were shipped; 150 men are now employed. Officers of the Edison Light Company are: Thomas A. Edison, president; F. R. Upton, treasurer; William Holzer, superintendent, and J. J. Bradley, master mechanic."—"Electrical World."

[The Edison Electric Illuminating Company was organized in 1880 with a million in capital. The incorporators of the company were: Tracy R. Edson, James H. Banker, Robert L. Cutting, Jr., E. P. Fabbri, who was J. Pierpont Morgan's partner; J. F. Navarro, also connected with Drexel, Morgan & Company; Grosvenor P. Lowrey and Nathan G. Miller.]

tion was formed to be known as "The Association of Edison Illuminating Companies" and a meeting was called for June 3, 1885, at Pittsburgh and notice sent to every Edison company and all manufacturers of the "Edison System." At this meeting the by-laws were drafted by F. S. Hastings, H. Ward Leonard and Frank S. Marr, the first secretary. The dues were fixed at $5 a year for each member company.

Later, on February 9, 1887, J. L. Barclay, P. B. Shaw and Wilson S. Howell issued a circular letter urging all Edison central-station companies

to join the Association of Edison Illuminating Companies, for as to our problems books are silent, our experience is short, experts are scarce and cost money, and each one works on his own theory and experience and tells you very little which is of real value. The central-station manager has an extremely difficult task of pushing a new business into favor and profit. He is a manufacturer who sells his product direct to the consumer and meets all the complaints of price, quality and quantity from people ignorant of the severe conditions under which he operates. He stands between two fires, the board of directors and the customer, who always wants two dollars' worth of light for fifty cents and compares the cost of the Edison service with the cost of kerosene oil or gas. . . .

. We should all work toward our main object—business success. For this purpose the Association of Edison Illuminating Companies is formed . . . Experience is a good teacher, but a hard taskmaster, and he who profits from the experience of others is wise indeed . . . A free exchange of ideas and experiences can do the best of us much good.

At the meeting of 1885 the discussion centered round the adoption of the new "three-wire system" (which, with the screw base lamp, has survived all changes) and the Edison chemical meter.

Mr. Shaw of Williamsport opposed the use of meters, claiming that his experience over several months showed that they were inaccurate and, of course, could not be read by the consumer, as could gas meters. He stated that his company had definitely abolished the meter system and was using the flat contract system of a price for each 16-cp. lamp per month.

F. S. Hastings defended the meter system, but admitted that where the use of lamps was long and fairly regular the flat rate system was the best.

John W. Howell surprised the meeting with the announcement that due to radical improvements in the manufacture of lamps, they could be furnished in several sizes of candlepower. The cost to the companies at this time was approximately 90 cents per 16-cp. lamp.

On August 11 and 12, 1886, a very important meeting of the association was held at Long Beach, N. Y. By general request, Frank J. Sprague, inventor of the Sprague motor, was invited to deliver an address on the possibility of selling "Electric Motive Power," and the Edison Electric Light Company was asked to prepare a full explanatory circular on the use and application of electric motors, giving table of sizes in which Sprague motors could be built and how the electric motor power could be sold and what the price should be per horsepower per year and how the horsepower could be figured.

At this meeting J. H. Vail made the startling statement that it had been found possible to operate arc lamps on the Edison system; that the American Electric Manufacturing Company had connected five in series from the positive and negative of the three-wire system and they worked.

As soon as the success of the Edison system became evident many companies took out licenses. In 1889 modern stations were started in Brooklyn, Philadelphia, New York and elsewhere and typified the latest practice of the time. In Brooklyn the station was equipped with cross-compound horizontal non-condensing high-speed engines of 250 hp. each, each engine belted to two Edison bipolar dynamos located on the floor above. The water-tube boilers were of 250 hp. capacity. The coal efficiency of the station was approximately 8 lb. per horsepower and the daily load factor 20 per cent.

The electrical gallery, located along the middle of the "dynamo room" and about 8 ft. above the floor, contained the most modern equipment. This consisted of solenoid ammeters, galvanometer type of voltmeters and knife switches for all dynamos and feeders. In series with each feeder conductor were large coils of iron wire resistances, termed feeder equalizers, hand-operated by a dial switch and used to cut down the voltage on a high feeder. Pressure wires laid with the feeders and connected to the street junction boxes brought the voltage back to the station. The station bus was operated at the highest voltage required by any one feeder and the voltages cut down correspondingly on the other feeders. The intense heat generated by these boxes during a heavy load almost overcame the attendants.

The underground systems were Edison tube, three-wire, the neutral being one-third the size of the positive and negative conductors. There were no recording meters, either at the station or on the customer's premises, where the Edison chemical meter was at this time in general use. All regulation was by hand by means of dynamo field boxes and feeder regulators. Ampere readings on the instruments were taken every fifteen minutes and the daily load calculated from these readings. As all instruments were constantly swinging

due to varying engine speeds, slipping belts, or varying load, the readings were far from accurate. This was the only electrical record available.

During 1889 the various Edison manufacturing companies were consolidated under the title of the Edison General Electric Company, and Samuel Insull soon became its president and continued as such until, through consolidation with the Thomson-Houston Company, the General Electric Company was formed with Charles A. Coffin as president. Mr. Insull then left the manufacturing field and actively entered the central-station industry as president of the Chicago Edison Company.

It is not possible in a short narrative to follow the rapid development of the electrical industry. There were often many stations and systems in the same locality, though none of them supplied what might be termed "universal current." Up to this time alternating single-phase current was used by Westinghouse. Thomson-Houston and others at 1,200 volts for series incandescent and higher voltages for series arc lighting and in some cases series motors. The Edison was the only low-voltage multiple system.

In 1897 there was developed in Brooklyn and Chicago the first multi-phase stations in this country, whereby all service supplied by the various systems was generated at one point and distributed through substations. In the design of the Brooklyn multi-phase station the engine-driven generator, of the unheard of size of 2,000 kw., was rather reluctantly wound for 6,600 volts, although no switching apparatus had been constructed for handling this pressure. The frequency was 25 cycles, for exhaustive experiments indicated this was the highest frequency at which rotary converters could be operated and not fall out of step with the generator. For transforming the high-voltage alternating current into low-voltage direct current transformers and rotaries were used. For transforming it into high-voltage direct current (for arc lighting) motor-generator sets were installed, and frequency changers (one machine) transformed the frequency for alternating distributing systems to 60 cycles.

From the outset trouble occurred in switches under the 6,500-volt load. The original switches were large metal-lined porcelain cups in which were plunged the copper rods, the arc being broken in the cup.

These first multi-phase switches were operated by compressed air. The arc was never broken without the entire switch following, and for a time thereafter the station could not be operated. Extensive experiments were made in the Brooklyn station over several weeks with all manner of devices with compressed air blowers, sand blasts, vacuum systems, etc. Finally, the original plunger switch was immersed in a tube of oil and immediate success resulted.

With the large multi-phase station covering an extended area, the former generating stations became substations and "superpower" became a reality. Soon interconnection of local generating stations developed interconnection of stations in various cities and transmission systems, as today, began to appear.

While the physical structure of the industry changed, there were developing modifications in financial structure. Whereas mortgages were practically closed at the outset, on the theory that subsequent equity financing would add security, as soon as it was appreciated that there could be no end to the growth of a system, a greater leeway was permitted in securities authorized and not issued. Finally the open-end mortgage, with serial issues at different interest rates, provided the flexibility which was required by an ever-expanding industry.

The introduction of the holding company in the late '90s furnished a means of successfully financing small independent properties, whose separate securities, especially equity securities, were issued in such small amounts as to be unattractive to the banker. As time passed larger properties were successfully grouped together through a holding company. Soon this method attracted the attention of parties who became interested, not so much in economical operation, financing and service to the public, as in speculative possibilities, and holding companies were superimposed upon holding companies beyond the necessary requirements of operating company financing. These securities were no longer "next to the dynamo," but were so very distantly related that the dynamo was finally lost sight of entirely. As long as prosperity ruled, the public forgot the operations of the dynamo, the basis of the securities, so that often the relations between the physical and financial structure were obscured or lost sight of entirely.

In the late '90s state regulation of operating companies stopped the exploiting of the industry by politicians and bankers and placed it on a firm basis. The same will no doubt hold true of the holding company, where federal regulation will seek to correct many of the abuses which have crept into a prosperous industry.

To many of us, whose greatest life's treasure is the memory of association with the Master Pioneer, it may appear that the major development work of this great electrical industry has been accomplished. This is far from the truth. There has today been laid but the foundation for enlarged future service. This foundation has been made possible through the latitude given the engineer and financier, whereby in operating companies the physical and financial structures have been brought to the present stage of development.

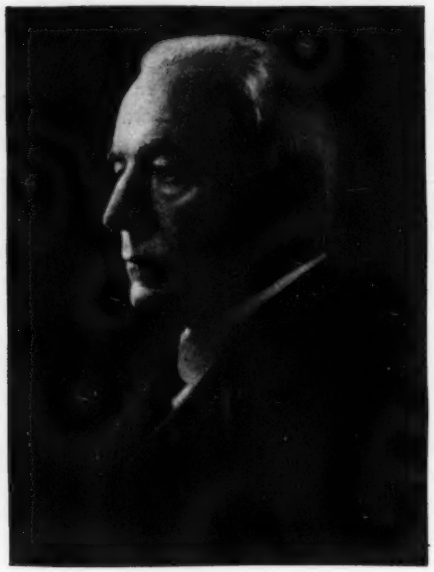
It would be regrettable indeed if, due to actions of those not interested in the progress of the industry and service to the public, there were to result a form of regulation which would go beyond the protection of the public, both as customers and investors, and restrict proper development. During the depression the electric public utility company has been ever true to past traditions of keeping faith in its service to the public.

The industry is now but marking time and looking toward future accomplishments, which without doubt will exceed the records of the past.

December 23, 1882—**In many cities there is a fierce and increasing demand that the wires shall be put under the ground and out of the way. There could hardly be anything more cruelly stupid than this suggestion. Are not our streets sufficiently ragged? Are they not torn up often enough? We rather like to see a great number of wires. We look at them strung in scores around our corner and over the roof with complacency. They mean business, and are not a bad index of the value of real estate. It is not becoming civilized men to be fretful about the most consummate, convenient and indispensable agencies of civilization.—"Electrical World" (Quoting the *Cincinnati Commercial.)***

Business and Policy Aspects

By GEORGE B. CORTELYOU
President National Electric Light Association



Industry growth premised upon low rates and general use.
Regulation on a conference basis.
Reasons for corporate structures and trends now current.

IT WAS on September 4, 1882, at 3 o'clock in the afternoon, that Thomas A. Edison placed in operation at 257 Pearl Street, in the city of New York, the first central station of the Edison system. It is hardly possible that the small group of friends and fellow-workers of the great inventor who witnessed this event visualized the tremendous consequences that were to flow from it; that here was loosed a mysterious force in a new and beneficent form that would encircle the globe in dazzling light and that would minister to the needs and desires of man beyond his wildest dreams. Yet such was the actual result. In the short space of 50 years the tiny infant which there first saw the light has grown into a veritable giant, with all a giant's strength, but it has not needed the admonition,

> O, it is excellent
> To have a giant's strength; but it is tyrannous
> To use it like a giant,

because this youthful giant has used its strength not to tyrannize but to liberate, not to fetter but to free. Electric power has been hailed as "the greatest labor-saving device of all times." If any one is inclined to doubt the truth of this, let him try to picture the world today without electric light and power and he will get some notion of the transformation it has effected in the life and destiny of man.

At first electricity was used only for lighting, but the lighting field was already occupied by gas. Edison believed in the superiority of electricity over gas as an illuminant—a belief which was vindicated by the event, for the electric light steadily and definitely displaced the gas light, even after the Welsbach mantle had given the latter a new lease on life. But Edison, with penetrating foresight, perceived that the loss of the lighting business was not necessarily fatal to gas, because there were other uses which offered it even greater possibilities. An entry in one of his early notebooks reads: "Gas will be manufactured less for lighting as the result of electrical competition and more for heating, etc., thus enlarging its market and increasing its income." This, in fact, is what came to pass, and what was at first regarded as a calamity was finally seen to be an opportunity—an opportunity for gas to establish itself in the heating field, where it found and filled a demand which brought it greater prosperity than it had previously known. Today gas and electricity, when properly co-ordinated and correlated, supplement and reinforce each other in supplying energy in the form of heat and light, the twin props of our modern civilization. Where they come into competition it should be possible, by the application of economic and engineering principles, to determine the natural line of cleavage between them so that each may do the work for which it is best fitted. Thus the maximum beneficial use of each will be assured and the best interests of both the industries and the public will be served.

So far electricity has not had to face the problem that confronted gas when it found itself threatened with the loss of its principal market; but I am sure it would meet such a situation, if it were presented, in the same spirit that its elder colleague met it and with the same result. It so happens, however, that electricity has never been ousted from any important field which it has occupied, having been able to retain the old while gaining new business. Its early trials and difficulties, though often formidable, did not prevent it from being rapidly assimilated into our economic system and in turn imparting to that system new impetus and direction.

A prominent leader in the utility industry once said: "It took about three decades, 30 years, to establish the commercial value of gas. Owing partly to the differences in general conditions of living and partly to the better original invention, it took but one decade to establish the commercial possibilities of the electric power and electric lighting industry." Gas, it must be remembered, made its advent more than 75 years in advance of electricity, in the opening years of the nineteenth century, when people were still deeply grooved in age-old habits of thought and of living, and innovations had to overcome a vast amount of inertia, prejudice and even superstition before gaining general acceptance.

We need not dwell overlong on the purely historical aspects of the light and power industry, interesting as these may be. In passing, however, we might note that for the first full year of operation of the Pearl Street station—1883—there was a net loss of $4,457.50, while

for the year 1884 there was a profit of $33,224. Contrast these figures with those for 1930, with gross revenues of $2,155,000,000 and operating income of $879,000,000—representing the output of thousands of plants, all of them descendants of the original Edison station. What a monument to human genius and to the power of the human will!

From the electrification of the home to the electrification of industry was a natural and logical step. This meant, of course, that the development of technical means had to keep pace with the expanding programs of management in response to the growing demands for service.

Few industries indeed owe so much to the scientist and the engineer as does ours, and it has been fortunate in the great manufacturing and engineering organizations with their technical staffs and laboratory and research facilities, which have supplied it with ever larger and more efficient apparatus, enabling it to extend, improve and amplify its service in a myriad of directions. Time and again the limit of size, power and efficiency of individual units was thought to be reached, but always science and invention stepped in to raise the limit and reveal new vistas beyond. The ultimate is something that may be pursued, but never attained, in the electrical industry. It is useless to predict what the future will bring forth, but it is safe to say that it will be full of surprises.

On the financial and business side the growth of the electric light and power industry has followed, in the main, the general pattern of American industrial expansion. The small and scattered plants which sprang up in the early years were gradually replaced by larger and more centralized units of greater capacity, and along with this went a parallel concentration of capital resources and management control. The past decade has witnessed a decided acceleration of this tendency, marked by the rise of the holding company. While there were the mistakes and excesses that seem to be inseparable from rapid and tumultuous growth, the important fact stands out that there was provided an instrumentality of greater strength, coherency and efficiency than had existed before. This was able to meet all the demands upon it for enormously increased service, without cessation or interruption, and upon a constantly descending level of cost. That is the essential truth which emerges from the heat and smoke of controversy, but which too often is obscured by this same heat and smoke.

The utility business as a whole has grown to its present proportions on the principle that the greatest profit as well as the best service flows from low rates and general use rather than high rates and restricted use. There is nothing peculiar or exceptional about this. It is merely the expression of an enlightened self-interest. As a result of its steadfast adherence to this principle, the industry can point to a record of declining costs over a period of years that is, I believe, exceptional. Especially for domestic or residential use, about which most of the clamor is raised, the price of electric service has shown a steady decline for the past 40 years, interrupted only slightly and temporarily by the World War. Since the pre-war year of 1913, the decline has amounted to about 34 per cent, while the cost of living in this country is still about 44 per cent *above* the 1913 level. Certainly on the face of it there is nothing here to warrant the politically inspired charges of excessive or extortionate rates. Quite the contrary, but experience shows how vain it is to expect the vote-catching politician to rest his case on proof instead of assertion.

Here we may pause to note the sharp line of demarcation between privately owned and publicly owned utilities in the matter of rates. With no intention of entering upon a general discussion of this subject, it may be pointed out that the one follows the economic method, the other follows the political method, and in this each obeys the natural laws of its being. As to the first—privately owned utilities—economic considerations being paramount, these require that rates be so framed as to encourage the greatest use of the service among all classes of consumers, without, however, subsidizing any one class at the expense of any other. As to the second—public or municipal utilities—the rule is that "rates are cheapest where votes are thickest." This of course results in an economically unbalanced rate structure, which in effect subsidizes one class of consumers, namely, the voters, at the expense of the commercial and industrial users, to the ultimate harm of all. The domestic user of electricity has a much greater stake in the business prosperity of his community, as that prosperity is enhanced by low rates for power, stimulating trade and increasing employment, than in having a few cents chopped off his monthly electric light bill.

If low rates for power had the effect of causing high rates for domestic use, something might be said for the political point of view, but the contrary is true, for, as Floyd L. Carlisle pointed out in his Atlantic City address before the convention of the National Electric Light Association: "Industries have filled the valleys of generation, and in practically every case where great industrial markets have been developed the rates to other classes of customers have been lowest."

Utility service is commonly looked upon as a monopoly, and so it is in the sense that only one company is permitted to serve a given territory, but there is plenty of competition for all that. I should like to see this subject gone into as fully as it deserves. What proportion of electric service is competitive? The commercial and industrial departments of the business are largely if not entirely so. If the rate is not right, we simply do not get the business. The prospective customer has

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***December 30, 1882*—The newspaper controversy which has arisen between the Edison and Brush Electric Light Companies in regard to the merits of storage batteries for domestic illumination is very much to be regretted as it cannot benefit either company and the only effect it can have upon the public will be to inspire a distrust of electricity in any form for domestic lighting. We cannot but think that the president of the Edison company has overdrawn the dangers attending the introduction of electric accumulators into households. It should be remembered that a much less powerful current than one of 2,000 volts will serve to charge the accumulators.**

President Eaton of the Edison Company: "The public do not distinguish between different systems of lighting. The Edison system was invented to supplant gas for domestic lighting and was made absolutely safe so as to be free from danger in houses. For that purpose Mr. Edison adopted a low-pressure current and carries it underground. The Brush and other arc light systems were developed for a different purpose, principally that of street lighting."

—"Electrical World."

***December 23, 1882*—Mr. Edison said to a reporter in Boston last week: "The largest undertaking we have on hand is to carry 15,000 hp. of electricity 18 miles into the city of Mexico, for the purpose of lighting that city and furnishing power for various purposes. We are only making estimates as yet. This thing of carrying power from waterfalls to a considerable distance is going to be done very extensively in the future. It is practicable to carry 25,000 hp. 20 miles if necessary."—"Electrical World."**

a choice of one or more alternatives and his decision is based largely on comparative costs. Even domestic service, which is usually regarded as non-competitive, has its competitive features, which are of increasing importance. It has been estimated by Luther R. Nash that "for a liberally equipped electric home more than 80 per cent of the service may have aggressive competition from gas, oil or other reasonably convenient substitutes." Many—probably most—electrical appliances for household use are sold on a more or less competitive basis, and the fact that sales of these have increased in recent years is proof that costs are not excessive, because excessive costs lead to reduced, not increased, sales. From every point of view, therefore, competition looms large in the utility business.

The light and power industry has been subject to public regulation for one-half of its existence. Regulation began generally to be adopted 25 years ago, and is now firmly established in our administrative system. Like all things human, it is not perfect, but by and large it has had a stabilizing and constructive effect which has benefited both industry and public. No one now would suggest that it be abolished except the few extremists who assert that regulation has "broken down," and therefore that nothing remains for the state to do but to take over the utilities and operate them itself; the theory apparently being that the state, having failed in regulating, would of course succeed in operating—a curious example of inverted reasoning which fails to impress the ordinary citizen.

If it is permissible to anticipate some of the dangers connected with a régime of regulation, it is that, following the well-known tendency of government bodies continually to expand and increase their powers, it may under one plausible pretext or another encroach more and more upon the domain of management and eventually strangle the initiative, enterprise and the exercise of executive judgment which are essential to the success of any business. If such a thing should come to pass. both the public and the utilities may well pray to be delivered from their protectors. But it should be possible to avoid this extremity. The utilities, on their part. should be scrupulously careful to observe the spirit as well as the letter of the law, and the commissions, on their part, should, so far as consistent, treat minor and occasional lapses of individual companies in their proper perspective and not necessarily as warranting a demand for a general enlargement of supervisory powers.

It would be strange indeed if the experience of a quarter of a century had not brought some improvement in the technique of regulation. It has, but there is room for further improvement. I have referred elsewhere to the fact that the relations between public authority and the utility industry have been conducted too much on the principle of "attack and defense" instead of on the principle of conference and negotiation. The courts must of course be open for the protection of legal and constitutional rights, but as a symbol of progress in the day-to-day business of utility regulation the conference board takes precedence over the courtroom. The historian of the future will surely wonder why this fact was not sooner recognized.

Now the suggestion is heard that another factor be introduced into regulation, namely, the federal government, inasmuch as a small percentage of electric power crosses state lines and thereupon, in theory at least, becomes interstate commerce. Federal intervention does not seem to be necessary or advisable at present, not only because the amount of such transfer is relatively small but because the state commissions control the rates charged by the local operating companies which alone supply the consumer. No one can contemplate the suggested piling of "Ossa on Pelion" in the regulatory field without considerable misgiving, in view of the fact that the federal government is already overloaded with a multitude of responsibilities and functions which most people think should be curtailed rather than extended. At least until the need clearly and unmistakably appears, it would seem to be unwise to inject another and an indeterminate factor into the regulatory situation which can hardly fail to produce uncertainty, confusion and unfortunate delay.

I have already mentioned briefly the holding company. This device is by no means peculiar to the utility industry, but has been employed extensively by many other industries and even by the government itself. It must be viewed, therefore, not as an isolated phenomenon, but as part of the general industrial scene.

The late Halford Erickson wrote the best and fullest exposition of the functions and economic bases of the utility holding company that I have yet seen. He left little to be added by subsequent commentators so far as the enumeration and description of its operations and benefits are concerned. There is no doubt that when used for its proper and legitimate purposes it is an efficient tool for extending, strengthening, bettering and cheapening utility service, but, like any tool, it may be wrongfully as well as rightfully used. Grave errors of omission and commission have been made in a number of instances which, while affecting only a comparatively small section of the industry, have been seized upon by utility critics as condemnatory of the entire system, as if all banks were to be condemned because some banks fail. The industry does not defend these mistakes, it does not excuse them; neither does it magnify them out of their true proportion. It recognizes them as evils to be eradicated, but not in such a way as to destroy the good with the bad; for in its normal functioning the holding company meets a real economic need and well and truly serves the public interest.

My personal view is that the holding company movement will in the future proceed in more orderly and less speculative fashion than in the past; that properties will be acquired with more regard to order and system and a better appreciation of the need for co-ordination of parts and functions. I believe that the multiplication of corporate affiliates has been overdone in some cases and that there will be a reversal of this trend; that there will be a resort to more simplified capital structures and simpler and more informative financial statements and

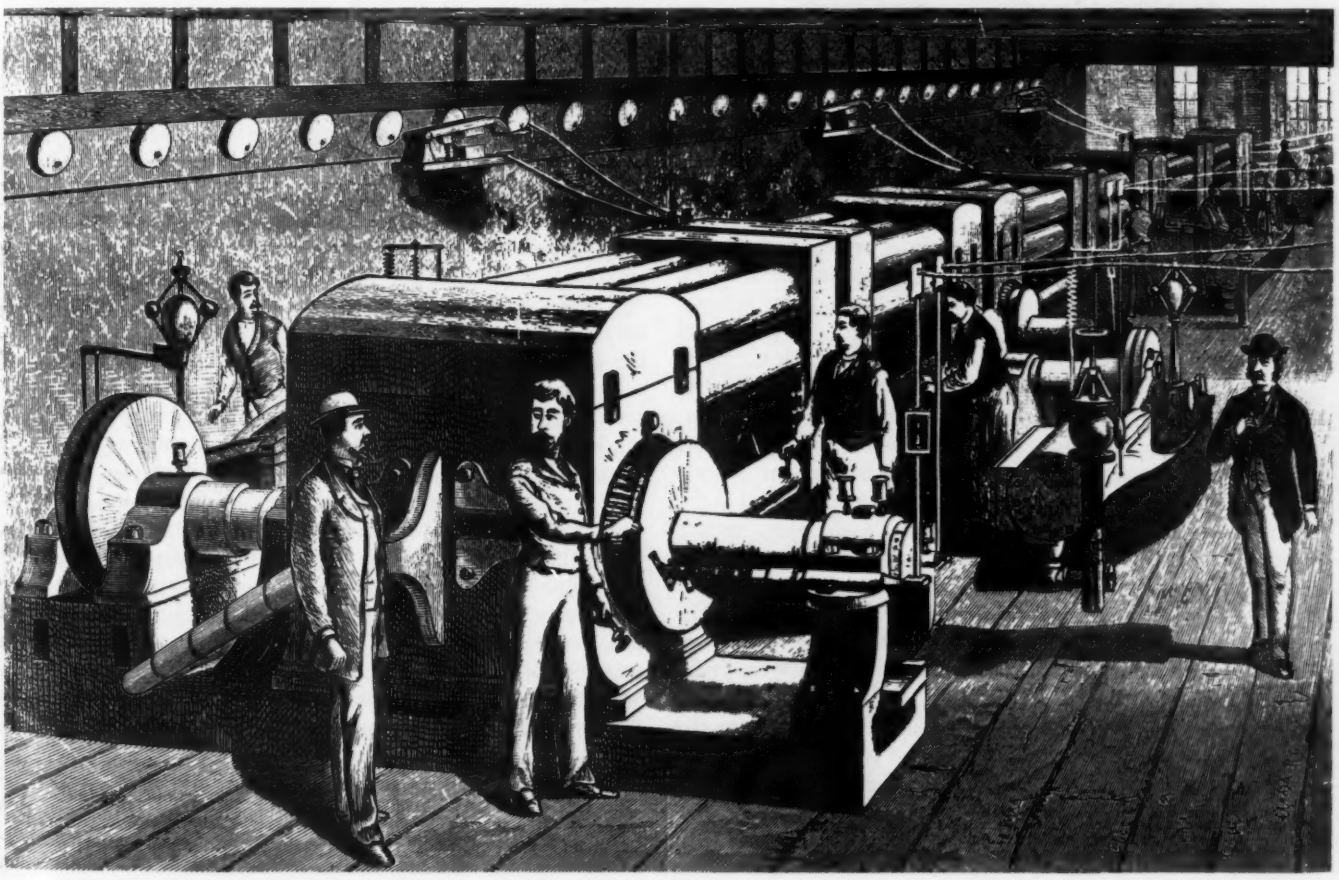
set-ups. Above all, there should be, and I believe will be, a keener sense of trusteeship on the part of management which will safeguard the investor and the public against the errors and abuses which have marred an otherwise excellent record.

Notwithstanding the phenomenal expansion of the electric utilities during the past decade in plant investment, gross revenues and operating income, the industry is not in the overbuilt condition that seriously embarrasses most industries. It is estimated that its generating capacity is not much more than 15 per cent in excess of the present demand. Construction expenditures have of course been slowed down by the depression, particularly during the present year, but much of this has been due to abnormal conditions in the money market which restricted the raising of new capital. In addition, the industry has had to provide for a large amount of bond and note obligations maturing this year, being, in fact, the largest amount of refunding required in any year of the industry's history. With the return of anything like normal conditions in business, the industry is in excellent position to resume the progress which was halted, but not stopped, by the depression.

When we consider the length and severity of the depression and that it followed a period of unprecedented expansion, the relative stability displayed by the electric light and power industry is nothing short of remarkable. We would be more than human if we did not take pride in the record. At the same time we know that past triumphs are no guarantee of future success. The problems of the future must be met and solved in the light of responsibilities and duties that extend beyond the economic and into the social realm. Great as the industry has grown, its field of possible growth is almost unlimited. Its actual business is still but a fraction of its potential business. Through research and investigation in exploring and developing markets, in increasing sales activities, in effecting further economies and efficiencies, in improving employee, customer and public relations and by every other means at our command we must prepare to realize the opportunities and fulfill the obligations that the future will bring.

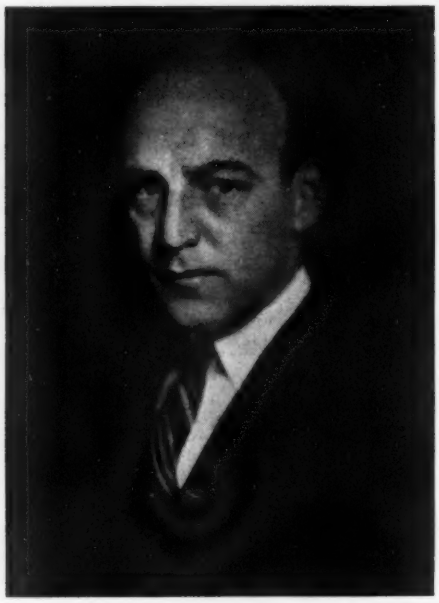
In addressing ourselves to these tasks, we may well draw inspiration from these words of Edison, taken from his valedictory to the great industry he founded: "Be courageous. . . . Have faith. Go forward."

GENERATOR ROOM PEARL STREET STATION



***September 15, 1882*—The first district of the Edison Electric Illuminating Company was publicly lighted for the first time on Monday, September 4. Two engines in the Pearl Street station were started and the customers of the company were notified that the light was ready for use. The first attempt to light a large district by incandescent lamps proved entirely successful. Mr. Edison's countenance showed that he was greatly pleased. "I have accomplished all that I promised," he said. "It was not without some fear that I started the machinery this evening. I half expected that some new phenomena would interfere with the working of the light. But it has been entirely successful. You will see that we have only one engine running now. It supplies 800 globes with light. We have six engines which will all be in successful operation before the end of the winter. The station contains the largest dynamos in the world, six of a capacity for 5,000 lights each. The district has been lighted daily since that time (September 4) and no hitch of any kind has occurred; over 3,000 lamps are connected."—"Electrical World."**

Industrial Power and Heat Opportunities as Great as Ever



By GEORGE E. WHITWELL
Vice-President Sales, Philadelphia Electric Company

GREAT changes and tremendous benefits, not only in the art of lighting but in the home, the factory and almost every phase of our lives, have sprung from that epochal event fifty years ago, when Pearl Street station was placed in service in New York City for the purpose of lighting some of its streets. While the illumination from those first street lights was a great improvement over anything that had been seen up to that time it was comparatively weak, judged by modern standards, and there were but small, dimly lit circles of light at the bases of the lighting standards with long, murky stretches between. The impetus it gave to engineers and scientists, however, resulted in tremendous forward strides and succeeding refinements widened the illuminated circles until soon they overlapped, and today we consider a street poorly lighted that is not bright from end to end. It was but a step from street lighting to house lighting, but it was a long stride from that into the power field and the diversified uses of industrial heating, air conditioning and the countless other applications in which electricity is finding an important place today.

Coincident with these advances has been an equivalent progress in the fields of communication, transportation and plant operation which have similarly widened the market which can be served by our factories. With every forward stride these factories have reached out into this new territory for new business, thereby competing with the local factories, until today there are many New England firms whose keenest competitors are located in the Carolinas or on the Pacific Coast.

Not only have industries met competition in reaching out into new territory but they have had to defend their own territory from others which were similarly expanding. Such competition has forced those which were to survive to devote every effort to the improvement of their product and the efficiency of their operations. Those which have failed to keep abreast of the times have been forced under, sometimes slowly, but none the less surely. It has been an era of change, of improvement of standards, and has seen an increase in wealth and living standards in this country that is unequaled in any other fifty years of the world's history. Even now business and labor in this country are relatively better situated than in foreign countries.

From the small start at Pearl Street station have also grown the great central stations of today—an integral part of the expansion that has been going on in all industries; a product of it and playing no small part in the advances which have made it possible. Their history has been similar to the history of the great industrials—steady improvement in quality of product and constant increase in efficiency which have led to price reductions and an ever-intensified search for new uses for electricity which would enable them to continue to expand and reap the rewards which follow.

The beginning of this era found the factory dependent for its power on the steam engine, harnessed to its work through long lines of shafting and a multiplicity of belts. Such a drive was high in first cost, high in maintenance and inefficient if carried beyond narrow limits. For large machines with heavy power requirements it was satisfactory, but as the power requirements of individual machines decreased the shafting and belting problems increased, and finally placed a limit upon the size of the group which could be driven. Small loads at remote points could not be reached with any degree of efficiency and small engines at those points were equally inefficient, while the shafting losses incident to operating a small part of the load on overtime work or when business was slack ran costs up and eliminated flexibility.

It was not until the advent of the practicable motor drive that these problems were removed and the size and layout of a plant could be made to conform solely to the requirements of efficient production without restrictions due to power supply. The perfection of the electric motor made it possible to segregate machines into convenient groups which could be efficiently driven, to apply individual drive to machinery which production required be remote from other machines, or which might be operated at times when the rest of the plant would be shut down. The design of the machines themselves has been simplified and their costs reduced by the replacement of the space-consuming, cumbersome belt and pulley drive with direct-connected motors which can be so located on the machine that they are the least in the way.

High transmission efficiencies have made it possible for the power companies to extend their lines and bring in new business which has enabled them to apply the principles of mass production to power generation and has so reduced their costs that they have been able to

sell power to industrial plants economically. This development has not only reduced their operating costs but has liberated capital for investment in productive machinery.

Industrial management has been liberated from the responsibility of operating and supervising the supply of power so vital to its operations and enabled it to devote its time to the productive phases of business.

While the mechanization of industry has progressed rapidly, it has not been accomplished at the expense of

Those who fail to keep abreast of the times are forced under, sometimes slowly, but surely.

Business competition shaking unwarranted complaisance regarding operating costs—forcing studies of economy of modernization.

Balancing outlay and return before investing.

efficiency or economy. Fundamentally human beings are prone to resist changes. The magnitude of the problem of altering the entire method of power supply and the capital investments necessary have aided this human inertia in preventing such changes without a great deal of pioneering and serious consideration of the relation between costs and returns. However, competition has acted as a whetstone. Accounting and far-sighted executives, who would not invest their company's capital in new equipment without first assuring themselves that the return would justify the outlay (either through improvement in product or decrease in operating costs), have been forced to make such economic studies in order to survive.

The power salesman has accomplished no small task in making the necessary detailed studies of the intricacies of a wide variety of businesses to prove, in many instances, to the factory manager that the power should be purchased and not generated. While the power salesman has been interested primarily in the sale of power, he has frequently had to convince the factory executive that the mechanical drive should be replaced with motor drive and has had to investigate, with the help of the manufacturers of both production and electrical equipment, nearly all phases of the businesses involved.

Generally the yardstick by which the advisability of undertaking a change has been measured has been operating cost. The keener the competition the more pressing are the demands to keep costs at the lowest point consistent with good practice and raise the quality of the product. Nowhere is this better illustrated than in the automobile industry, where a rapidly expanding market attracted production facilities which have resulted in a bitter struggle for market dominance that, for years, made price the dominating factor. Under such conditions operating efficiency was of paramount importance and nearly as much time, thought and planning had to be given to the layout of the factory as to the product itself. Every operation had to be studied in detail, not only in itself but in relation to contiguous operations. Every element of time and lost motion had to be reduced to the minimum. As a result the modern automobile factory is one of the most completely mechanized in the world and is laid out so each operation is performed in the minimum of time on a predetermined schedule, whose accomplishment is assured by mechanical conveyors.

Such investments cannot be made without a careful balancing of the relation between the outlay and the return as affected by such considerations as quality of the product, market conditions and obsolescence. A competitor in a field which is subject to rapid changes in style or standards can ill afford to make a large investment if the returns will not retire that investment before the equipment becomes obsolete and has to be replaced. But a return which would be inadequate in such a field might be thoroughly justified in one where conditions are more uniform and where market conditions can be predicted over a longer period of time.

The solution of such problems was a necessary preliminary to the entry of the central stations into the power field and involved primarily questions to be solved by the manufacturer, the machine designer and the motor manufacturer. But the need for expansion and diversification of load made solution of these problems of vital interest also to the power companies, and their salesmen were extremely active in the task as a preliminary step to opening the question of competitive power costs. Through their experience in solving those problems has come a better understanding of the problems confronting the industrial executive and of the methods by which the power companies could make their service of the maximum benefit to their customers.

Their search for new applications of electricity has gone on constantly and has been effective only in proportion to their understanding of the details of their customer's business and their sympathy with his point of view.

Benefits from these relations have not been one-sided. The efforts of the power companies to secure this new load as early as possible have led them into closer relations with the manufacturers of electrical equipment. As a result the development of many devices which have been of inestimable value to industry have been hastened, if not entirely brought about, by the demands of the power companies for the production of equipment which would enable them to increase their sales.

The investigations and reports of comparative power costs worked up by the power salesmen have shaken many a manufacturer out of an unwarranted complaisance regarding operating costs which had been seriously af-

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***February 24, 1883*—The most interesting occurrence in electric light circles during the past week was the award of the contract for lighting the Brooklyn Bridge. On Saturday last the committee appointed by the board of trustees awarded the contract to the United States Illuminating Company of New York, which is a local organization for this city and vicinity of United States Electric Lighting Company.**

***May 26, 1883*—Lighting the Brooklyn Bridge on Saturday evening, the 19th, was an event which gave the numerous reporters of the city press a fine opportunity to soar into lofty poetical altitudes. "The seventy (2,000 candlepower) lights blazed over the ship channel like an arch of stars. Tugs whistled, men shouted. In New York, Brooklyn, Staten Island, for miles and miles around the two cities men pointed to the splendid spectacle of lightning at work for man. Ferryboats and passing tugs which looked like miniature crafts tuned their steam whistles and this latest evidence of the near opening of the bridge was hailed with delight."—"Electrical World."**

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fecting profits. It was not so many years ago that where any uses for process steam existed power was regarded as a by-product which cost nothing. It was not until the searchlight of the utilities' engineers was turned on the plant that the fact was discovered that power and steam requirements are not necessarily equal, or coincident, and the true cost of power was determined. Their insistence on facts regarding power costs has even led, in some cases, to improved power accounting by plant operators which has led to reduced manufacturing costs, even though it did not result in the utility getting the business.

These studies have also led to steady improvement in the rate structures of the power companies as competitive costs have become better understood. Sales departments have conducted a great amount of research into the field of competitive rates and have been highly successful in obtaining rate reductions in directions that have been of the most value to customers and have opened new avenues for sales efforts which would secure the most new business for their companies. This work has also led to a much-needed simplification and standardization of rate forms.

- Success in servicing new business proportional to understanding of customer's problems and viewpoint.
- Benefits not one-sided.
- Simplification of rate forms and reduction of number—a major problem.
- Four sources of new business—their relative possibilities.
- Growth depends on finding, perfecting and promoting heretofore undeveloped uses.
- Three essentials of successful promotion.
- Heat applications afford most prominent field for extension of use.

A tremendous sales resistance can be engendered by rates which are difficult to understand and by the customer's confusion over differences in rate structures in different territories in which he may be operating factories. This is one of the major problems confronting our industry today and one in which a great deal remains to be accomplished.

The advantage to the power company of having a group of engineers as an integral part of its sales department to make such studies is tremendous. If they are younger men they can bring a freshness of view which is desirable. At the same time the knowledge they gain in making these studies is an excellent course of training which will fit them to fill vacancies in the sales ranks through an intimate knowledge of the economics of plant operation and rate applications. Such a group can supervise the tests and compilation of competitive reports, the preparation of analyses for rate recommendations and analyses and surveys of new applications which it is desired to feature.

In the past there have been four sources of new business open to the sales department: (1) Replacement of isolated plants, (2) additional load from plants already on the system, (3) new plants starting in business and (4) new applications of electricity which increase the load in existing plants.

The first of these opportunities is diminishing in so far as economics decrees that the business is soundly that of the utility and as aggressive sales work, wear and obsolescence take their toll. The remaining isolated plants generally have high heating and process steam requirements which permit of a close heat balance between power generation and process-steam requirements. Their number is steadily diminishing as rates are reduced, as parallel operation is adopted and as small plants are built by the power company to supply both heat and power as is being done in some cases. The latter practice offers the advantage that the plants need be only large enough to supply steam requirements, drawing excess power from the company's system and relying on it for reserve capacity. They can sometimes be constructed to supply several plants. They free needed capital for the industrial, taking it from the power company, whose business it is to invest in such plants. On the other hand, they can only be embarked upon where the product of the industrial is unusually stable and where market and production conditions can be confidently predicted for a number of years, as the undertaking of such a project demands long-term contracts.

The second and third sources of new business—new plants and additional load from existing plants—are largely beyond the control of the power company as they depend on general business and market conditions encountered by the industrials themselves. Therefore they offer little opportunity for the power company which is embarked on an aggressive program of expansion, except where promotional rates create new demands or can influence changes in operating schedules which, while not procuring new load, will result in an increase in off-peak load which will be advantageous in improving overall load factors and operating economies.

Therefore it seems certain that our growth in the future must depend upon our success in finding, perfecting and promoting heretofore undeveloped uses for electricity.

Such a program can be undertaken only with the greatest care, planning and forethought and a thorough knowledge of the application and its field. Time and money can be wasted in the promotion of applications whose fields have been over-estimated. General acceptance and use of a really valuable development may be delayed for years by its premature promotion.

***March 31, 1883*—The Edison Light in Chicago. The Western Edison Light Company has closed a contract for installing a building of seventy lamps in the Merchants National Bank building, Chicago, to be operated from machinery in the basement.**

***March 31, 1883*—An Edison Company in Boston. The Edison Electric Illuminating Company of Boston was organized in that city on Wednesday, March 28, with ex-Governor A. H. Rice as president. The capital is one million dollars. A central lighting station will be immediately established in the business portion of the city with a capacity of 20,000 lights.**

***May 5, 1883*—Edison Light of St. Louis. Mr. William McKee Brewster, special agent for the organization of local branches of the Edison Electric Light Company of New York, was in St. Louis last week making arrangements to illuminate the central part of the city. It is reported that a company has been formed.**

Three Essentials—There are three indispensable preliminaries to embarkation on a promotional campaign, all of which can be most efficiently and economically performed by a sales engineering group such as has been previously mentioned. The first of these involves a detailed investigation of the development itself, its nature, efficiency of operation as compared with existing methods, investment required, and the rate necessary to put it in the field of competition.

Once these factors have been thoroughly digested the question of available load in relation to the cost of conducting a promotional campaign must be carefully studied. Satisfactory solution of this question involves a complete survey of the territory served and a detailed knowledge of not only the plants having such applications but of their markets and financial situations. As time goes on we are going to find that we must have a more and more intimate knowledge of our customers and that the cost of such campaigns is going to be reduced and their success increased if we set out to acquire this knowledge in a systematic way rather than depend on separate surveys for each undertaking.

Finally, the organization and execution of the campaign itself, granting proper preliminary work, will be the deciding factor in its success, and upon the success of a number of such campaigns will depend the future growth of our entire industry. They can be successfully carried through only by proper co-ordination of general and direct-by-mail advertising, followed by personal calls by our own salesmen, backed by closest co-operation of manufacturers' and contractors' sales organizations.

Probably the most prominent and largest field for such extensions of the use of electricity is in the heating field, which comprises a range from the great steel furnaces to small immersion units of 150 watts, from bake ovens in commercial bakeries to coffee percolators in drug stores.

Our imagination is captured by the larger iron and steel furnaces on account of their size and picturesqueness and the possibilities for large loads. Both classes of work offer advantages, particularly where exactness of results is of importance and fineness of control is essential. In the cast-iron field it is possible to produce high-quality castings with lower grade scrap than with fuel heat and the exactitude of electric heat control gives it a great advantage in working with high-grade alloys. Electric heat offers the same general advantages to the steel man, though from the viewpoint of the power companies this type of load does not offer the possibilities that iron does, because of the fact that there are more small iron foundries scattered over the country than steel foundries, which are more inclined to centralize in certain localities.

Great as are the possibilities of these larger loads, they do not lend themselves to promotional work. They are in competition with fuel firing and they do not have other attractive features to the user that smaller loads possess. The competition with fuel is of primary importance in this class of load because plants of the size of those using this type of furnace buy such large amounts of fuel that they can obtain good prices and our rates must be very low to compete. Undoubtedly our rates will continue their downward trend, and as they do we will get more and more business from this class of customer.

Tremendous field in diversified applications of small heaters to industry and commerce.
Electric cooking and baking coming into greater prominence.
Great opportunity of all air conditioning.
Representative installations force others through competitive urge.
Existing and new developments assure opportunity for better record than last 50 years.

It is in the smaller furnaces that we have the advantages and, in the aggregate, greater opportunities. The small furnace operator who deals in small quantities of a highly specialized product, the refiners of precious metals such as jewelers, and similar furnace operators can justify a higher differential than can the big iron and steel foundries. Their plants are smaller and frequently do not have the advantage of railroad sidings to reduce their fuel costs; they are in smaller quarters where the cleanliness of electric heat can be accounted a definite advantage, particularly if smelting is only a part of their work, and they deal in more exact specifications where the perfection of control of the electric furnace is of calculable value.

A tremendous and highly profitable field exists, which has scarcely been touched, in the application of small strip and immersion heaters to miscellaneous applications in nearly all branches of industry.

Besides the load possibilities it offers two attractive features to the power company: (1) It will result in measurable increase in the use of the average industrial and commercial customer at a correspondingly attractive rate, and (2) it will continue to increase our loads after the more intensive promotion is completed because of the low first cost and simplicity of installation and operation which will create a demand for them, once the operator has become familiar with their features.

An idea of the possibilities of this load can be obtained from the fact that in the last five years, without any special promotional effort, more than a million kilowatts of these units have been added to the power companies' load.

These units include the strip, immersion and cartridge types. Strip heaters can be used to advantage in small driers, or large ones, where other means of heating are

June 9, 1883—**An Edison Company in Milwaukee—What has been known on paper as the Edison Electric Light Company of Milwaukee has at last assumed tangible shape through subscriptions to the capital stock sufficient to enable an organization and the commencement of operations. The company will be officered in a few days.**

October 13, 1883—**The Central Lighting Station at Brockton is a one-story brick building. The main conductors are laid under ground. Edison's recently devised "three-wire system" which brings about a saving of 62½ per cent in the weight of the copper required for the conductors being used.**

June 14, 1884—**Portland, Ore. H. W. Cole writes: "I have organized a company in this place with a capital stock of $100,000, paid up $50,000. We are putting in a plant of 150 arc lights and are arranging for a large incandescent plant. We will use the Westinghouse engines."**
—"Electrical World."

***December 27, 1884*—Electricity for the Elevated Roads. Prof. Moses D. Farmer has furnished Mr. Cyrus W. Field an estimate of the cost of operating the Second Avenue elevated railway of this city (New York) by electricity as compared with steam.—"Electrical World."**

not readily available; in small auxiliary space heaters to provide for special conditions or night heating in summer, and for an infinite variety of other uses. Immersion heaters can be used in glue pots, solder pots, melting pots, chemical and cleaning baths. Cartridge units are for installation in blocks to provide heat at specific points on machines such as for the gluing operation in making paper bags. Altogether there are some twenty thousand different heating operations for which this type of unit can be used, varying in size from one hundred watts up.

Electric cooking and baking are also coming into greater prominence each year as the quality of electrically cooked foods comes to be appreciated.

The absence of any odors of combustion, the retention of the natural juices and flavor of the foods and the decreased shrinkage in cooking are all recommendations that cannot be ignored. The restaurateur can evaluate the benefits of these as well as the advantages of uniformity of results and improvement of morale among employees.

Probably the greatest opportunity of all, at the present moment, is air conditioning, which offers advantages to the user and peculiar advantages to the power companies. The load is ideally suited to our seasonal load cycle, offering a small but high load-factor winter demand from fans and pumps, together with a large high load-factor demand from the compressors during the summer months, when other users of power and light are not busy and when we have spare capacity.

Originally developed because of the requirements of temperature and humidity control in working hygroscopic materials, air conditioning has been seized upon by theater, store and restaurant operators as a means of eliminating, to a large extent, the summer slump in business which was caused by weather conditions. It is now being rapidly extended to offices and factories as a health measure which increases the production of the individual and reduces the time lost through illness and overfatigue, induced by high temperature and humidity. It is now being adapted to use in the home as improved design and production make it possible to produce small efficient units at a moderate cost.

Air conditioning offers almost unlimited load possibilities and is particularly adapted to promotional work. Like all new developments, it requires time and experience to perfect the equipment and to procure acceptance and demand from the public. The equipment has now passed the development stage and we must concern ourselves with its acceptance and the creation of a demand for it. These applications would, of course, appear of their own volition in course of time, but our job is to hasten them and secure for our companies the additional sales and revenue that is available by creating this demand and securing the load two to five years before it would appear if we did not step in.

A promotional campaign, aimed to secure representative installations in different classes of business, will create wider demand inasmuch as a few applications will make it necessary for operators in the same lines of business to make installations of their own in order to retain the patronage of a public which will demand air conditioning once it comes to the realization of its comforts.

Air conditioning can be secured by the smaller user, who cannot afford the more expensive compressor units for cooling, by the installation of ice or steam units. These are slightly more expensive to operate but lower in first cost. We can well co-operate with the ice manufacturers' associations as well as equipment manufacturers in promoting such installations, for the more agencies which work on such campaigns the less the cost to each and the greater the results obtained.

So far, the writer has attempted very definitely to base the future upon only those things that are definitely known at present. For example, there can be no reasonable doubt but that air conditioning and small electric heating devices are far enough along right now and have sufficient public acceptance so that their increased use is only a matter of intelligent effort.

However, there is one new factor already working in industry and commerce that may grow to have widespread influence way beyond the scope of present applications—it is the effect of electron-tube and photocell application on manufacturing processes.

Let me quote from a letter just received from a friend who has had an excellent opportunity to view business and industry in perspective. He says:

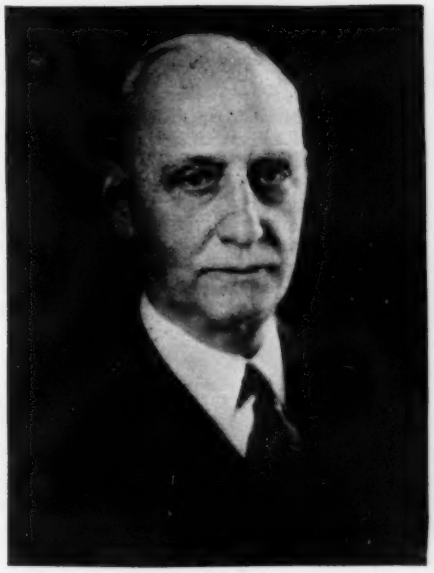
> I feel that these devices will permit mechanizing operations which have until this day been performed by human beings. They may not supplant human judgment which involves weighing values, but I do believe that they can synthesize mechanical observations, so to speak, and produce results comparable to human judgment. This may be done more accurately because their synthesis of values can be definitely set and based on the best opinion, whereas operation dependent on human observation and judgment is dependent on the individual involved and how accurately he observes and applies the experience he has or the instructions given him.
>
> If this be true, operations never performed mechanically before will come into being and they may entail extensive mechanization throughout all industry because of the new machines needed, the new outlets for raw materials, etc. As a result, there will spring up new manufacturing groups, increased activity in the raw products fields serving these groups, sales distribution and servicing groups, etc. These will develop new opportunities for employment and increased purchasing power.
>
> Personally I feel that if every one can be made to see the opportunities we may have as great development as was caused by the commercialization of the electric motor.

While these comments appeal to the imagination and indicate marvelous possibilities yet to be attained in the application of electric power, it is questionable whether increased mechanization should be stressed at the present time. A prosperous future depends to a large extent upon solution of the immediate unemployment problems.

Just a few of the possibilities that the future holds out to us have been cited. There are numerous others which are available *at this time.* New and possibly unthought-of opportunities will surely present themselves from time to time which can be developed into worth-while and profitable loads to our industry. If we attack these problems with energy, intelligence, determination and a real regard for economics there is no question in my mind but that the continual growth of the utility business will be assured, and we will be able to turn the industry over to our successors with as much pride and as high a record of achievement as our predecessors.

We Have Traveled Far Since Pearl Street

By FRANK W. SMITH
President New York Edison Company



A HALF century of electric service! That is what we have been celebrating in connection with the anniversary of the opening of Edison's historic Pearl Street station on September 4, 1882. Yet when we consider the great power plants of today, long-distance transmission, the millions of customers and the billions of kilowatt-hours produced annually, the thought is bound to occur—"*only* a half century of electric service!"

Surely no business has had a record of development and usefulness to mankind within the short space of 50 years surpassing that of the electric utilities! Surely no business, whatever its age, can look forward to a future of more promise in growth and increasing usefulness!

It has been my fortune to be connected with the local electric utilities for that entire period, first in 1880 with one of the predecessor companies which was, of course, an arc lighting company—to have seen an industry created and grow great. The word "created" is used advisedly, for there was no precedent for what Edison and his associates did—everything had to be built from the ground up.

Edison knew exactly what he wanted to accomplish. He wanted to bring about the utilization of electricity for light and power. His incandescent lamp, remarkable as it was, happened to be only one feature of his broad plan. It was necessary to design and build dynamos bigger and more efficient than had ever existed; to construct and equip a power plant; to invent a distribution system with proper voltage regulation, manufacture materials for it and lay it underground (which had never been done successfully); to devise and manufacture fixtures and wiring equipment for use in buildings; to invent an accurate meter; to obtain customers and wire their premises. Within three years from the time of perfecting the incandescent lamp, the big job was done. It was done so wisely that principles then established have become basic in the technique of power supply.

Edison also knew his market. Before the Pearl Street station and the distribution system were laid out a careful and complete survey had been made of the light and power requirements of the district to be served. Every building in the area had been canvassed, every gas jet had been counted, every elevator listed, every manufacturing process noted for which electricity could possibly be used, even to the replacement of horses which operated treadmills. Therefore, he had a guide both as to station capacity and prospective revenue. The same procedure was followed before stations were built in other areas of the city.

Thus the Edison Electric Illuminating Company was started on a sound basis—sound as to engineering; sound commercially. We, of today, may properly be proud that the industry throughout its development has maintained these characteristics, and that even in the last couple of years operating companies have kept their service unimpaired, have enlarged and improved their service facilities when necessary, and by their purchases and their payrolls have contributed largely to the prevention of worse conditions than those we have seen.

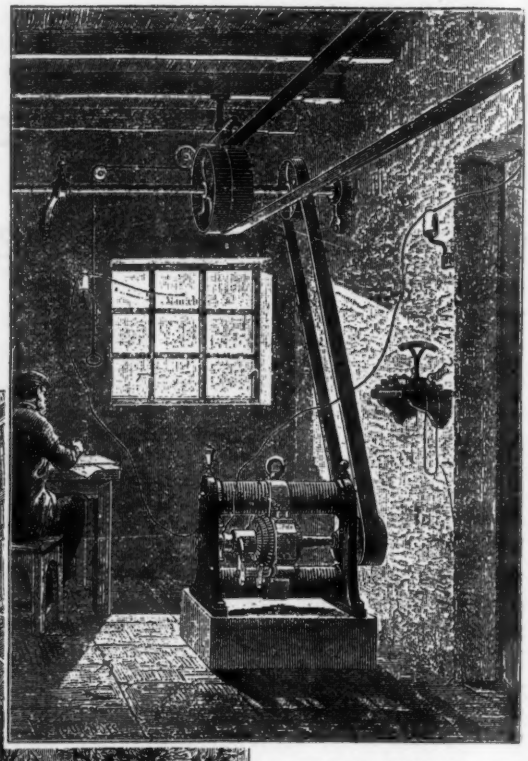
Edison had the spirit of service. He planned and worked to give to mankind something better, something more useful than then existed. In doing the job he didn't spare himself or his fellow workers, and he managed to imbue them with the same spirit. The job became almost a Cause which they served with zeal. That is still the attitude of electric utility people toward the job, and I have confidence that it always will be. Electric service is so vital in the life of each community that we, its custodians, cannot and dare not let down.

Since Pearl Street we have traveled far. Electric service has girdled the globe. It has, perhaps more than any one element, contributed to our industrial development and our present high standards of living. It will in future contribute to comforts and convenience and blessings yet undreamed of. Pearl Street holds for us and for those who come after us a lesson—the example of Edison—to build soundly and to infuse the job with the spirit of service. On that basis we can make certain that the future will be worthy of the development from 1882 to 1932.

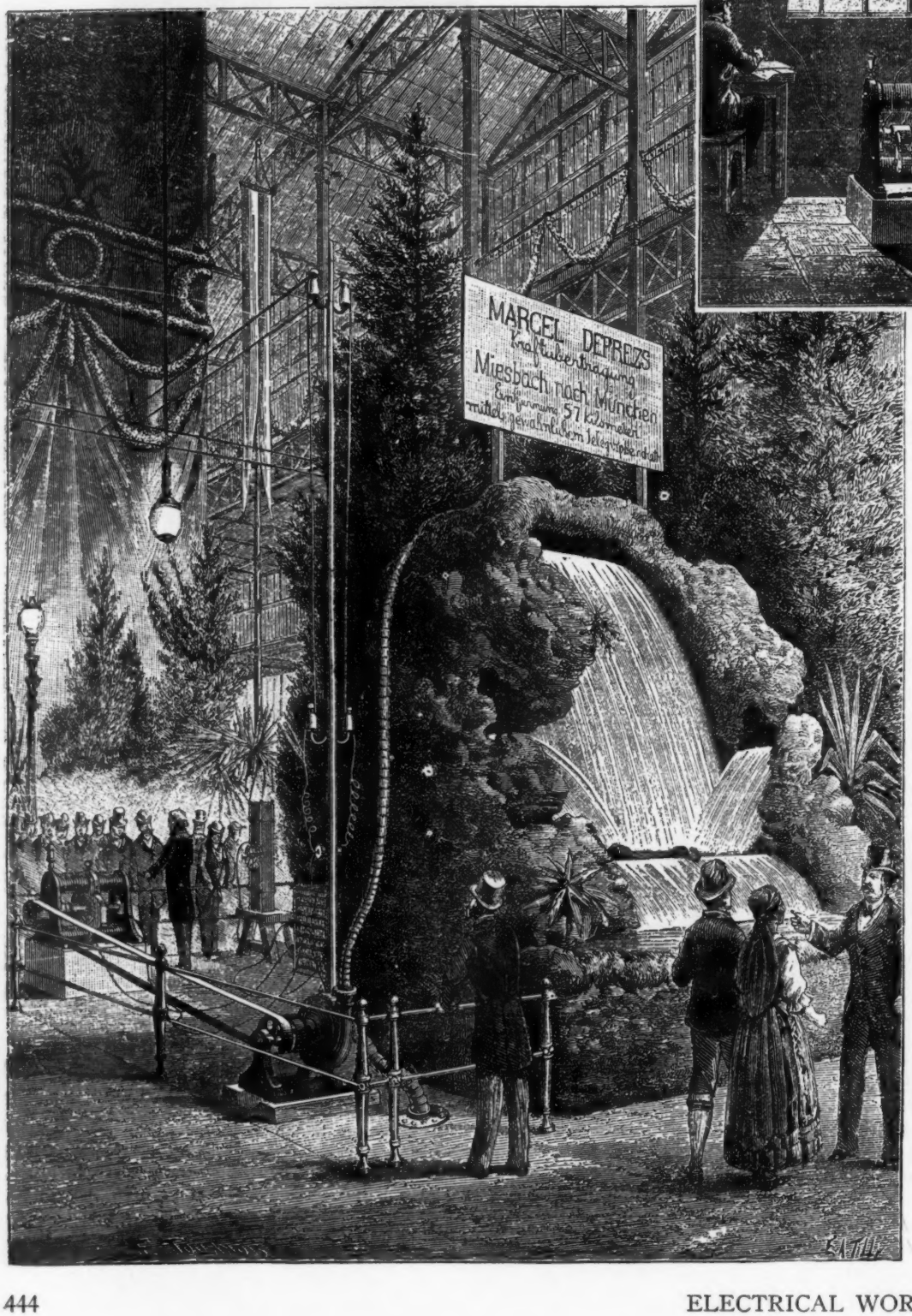
***October 28, 1882*—At a meeting of the Edison Electric Light Company on October 24, the following trustees were elected for the coming year: Norvin Green, S. B. Eaton, G. P. Lowrey, Thomas A. Edison, E. P. Fabbri, Henry Villard, James H. Banker, Calvin Goddard, E. D. Adams, F. W. Foote, Jose F. de Navarro, E. H. Johnson and W. H. Meadowcroft. The following officers were elected: President, S. B. Eaton; vice-president, E. H. Johnson; treasurer, E. P. Fabbri; secretary, Calvin Goddard.**
—"Electrical World."

4/10 HP. TRANSMITTED 35 MILES AT 2,200 VOLTS

November 8, 1884—The Munich Experiments. In the official report of the Munich Exhibition, O. Von Muller says: Deprez employed in the Munich Experiments electromotive forces up to 2,200 volts, this being the highest potential hitherto used for electrical transmission of power. The greatest attention could reasonably be claimed for the experiments of Marcel Deprez, who, with ordinary telegraph wires 114 km. long, succeeded in the electrical transmission of power to the greatest distance hitherto obtained. Deprez was certainly the first who, according to the request of the committee, established, by means of an experiment on a large scale and



GENERATOR AT MURBACH



one intelligible to the general public, the practicability of his calculations on the transmission of power to great distances, though these calculations were frequently considered to be nothing more than interesting scientific speculations. The machines employed by Deprez in the Murbach, at a distance of some 35 miles from Munich, absorbed about 1.5 hp., while the available work obtained in the Exhibition amounted to about 0.4 hp., employed in setting in motion by means of a centrifugal pump a waterfall eight feet in height. —"Electrical World"

December 15, 1883

Trends in Transmission

Responsibility of industry and leaders.
Broad-range perspective needed to co-ordinate specialized functions.
Visualize economic ultimate and build toward it.

By PERCY H. THOMAS
Consulting Engineer, New York

THE present occasion is an admirable time for a detached and thoughtful consideration of the present position of electric power transmission and for a most earnest examination of the trends for the future. The unbelievable expansion in the use of electricity in the fifty years since the starting of the Pearl Street station—an expansion still proceeding, broadly considered, at a rapid pace—has advanced electricity to a leading place among the most important factors in our national industrial life. *Noblesse oblige,* consequently the industry has the responsibility for an economical and sound development. Manifestly, it is the duty of the leaders to exert themselves in directing the trends for the general good.

As the power systems of the country grow into their more or less permanent form, during the coming years, economy of construction and operating costs is of greatest importance. The industry has pretty well completed the stage of rapid expansion during which service has been extended right and left to reach new territory and in which systems adequate to supply heavy industry have been developed. This has involved much haphazard growth and many consolidations. Engineers doing this work have labored under great handicaps, limited in their perspective by confinement to the particular work in hand and by lack of data for broader-gaged planning. For this the engineer is not wholly to blame.

Hereafter conditions are likely to be different. Large amounts of new construction must be carried out. Much can be done to strengthen and make greater use of present installations. An opportunity for marked economy is presented. On the other hand, any unnecessary expense incurred hereafter can hardly be recouped. The great hazard of all rapid growth, especially dangerous with utilities, is wasteful construction. Too great a system cost is certain to be a heavy burden.

Unless purposefully guided, future construction, like the past, is likely to be piecemeal and governed by immediate local interest, so it should be clear that responsibility lies on the entire industry to clarify the objectives and supply the leadership and pioneering necessary to secure an economical and effective whole. This matter is of no small moment.

The necessity for leadership has greatly increased, as the detail steps of growth have passed more and more into the hands of specialists and routine staffs who are in a too-detached position to consider the good of the industry as a whole. The leadership here envisioned is not easily defined. It should not only indicate to designers sound technical methods, but should also supply moral support to the forward-looking engineer who wishes to make a departure from the usual practices. Without this moral support the steps in advance may be long delayed.

Interesting as this subject is, space will not permit discussing it further, as the purpose here is to consider some of the concrete practices, the definite problems and the indicated developments engaging the present attention of progressive engineers. For the next ten or fifteen years a larger stake hangs on the economical spending of money and the sound development of new construction than most realize to be the case. The price of economic success for the industry is continuous study and bold use of initiative and originality. Standardization is a powerful instrument for effecting economy and service, but has its place in routine matters and for the guidance of regular operations. Unnecessary standardization is a most serious handicap to progress.

Decentralization of Power—Retrospection reveals the fact that our transmission systems, taken individually, have developed much as a river crosses the country, following the path of least resistance, spreading out where the going is easy and narrowing into turbulence in the rough spots. The net result leaves much to be desired. Navigation could be enormously benefited if the Mississippi could be relocated in an artificial channel. While it is too late to rebuild our transmission systems, an overshadowing growth will no doubt characterize the future, so that if the ultimately economical system can now be foreseen, new installations can transform the existing ones substantially into the economical layout visualized.

The new point of view will be to correlate operation of units and methods of doing so rather than to confine attention to details, as is now largely done. The new problem will be to establish unitary service to contiguous, continuous areas, with responsibility only to the interest of the whole. The goal will be over-all economy of cost, including capital charges, more or less regardless of the amount of the energy losses in individual elements, because generation costs have become almost negligible in the consumer cost, except for very large users.

The most important factor of economy will be the

maximum utilization of the units of the system. Well-known factors limiting such use are apparatus held in reserve, low power factor, unnecessary distances of transmission and failure to use available units for the greatest number of services. The effect of these factors is far reaching and in the aggregate may lead to very important increases in capital cost.

One point of view deserving consideration can be illustrated by referring to the two outlines of conventionalized distribution systems, marked A and B. A is a group of three independent systems, with the main

Standardization valuable but must not bar progress.
Unitary service vs. diverse individualized operations.
Decentralization of generation and loose-linking of stations.
Longer spans with guyed conductor supports.
Rationalizing insulation values.

power houses interconnected, but each system maintaining its own voltage and responsible for its own load. An interchange of surplus power may be had, and also volunteer mutual aid in case of an accident in one system, but each maintains its own independent operating force and its own individuality.

B shows the same area supplied by a single low-tension network, still with three power houses, each supplying feeders to the neighboring territory which, in some degree, overlap feeders from other power houses but without actual feeder interconnection. The whole system is operated as a unit. The advantages in economy and operating facility of the B layout will be found to far exceed what a superficial view might indicate.

The part of the territory in B lying between the three power stations, aggregating over half the total, is common ground and may be supplied at any point from at least two stations through the low-tension network. The load on any power station will vary as a greater or less amount of territory receives power from that station. If an additional generator be thrown on the line in any station, the result will be a proportionate increase in the territory served by that station and a corresponding reduction of output from the generators operating under governor control. This action is entirely automatic and needs no prearrangement with other stations, unless the change be excessive in amount. Such increase in load causes virtually no increase in line loss, whereas a transfer of power between power houses in layout A may involve transmission distances from two to three times that in case B. The low-tension network being continuous in B, power may not only flow in any direction but can spread out in all directions in accommodating itself to changes.

Since power can flow in either direction in the low-tension network, it will act in B as an interconnection between the power houses for maintaining synchronism —an interconnection acting at all points where the feeders from the power houses approach one another and one which is well cushioned electrically. The capacity of the interconnection can be easily controlled by its location and capacity of the feeders. These interconnections are so distributed that hardly any conceivable accident can affect proper functioning.

With such a system, called a loose-linked interconnection by Alex Dow, there is a minimum of concentration of power at any point, always a source of great expense and a threat of serious interruption. In system B reserve apparatus should be in the form of unused capacity in the operating units, thus always available and directly useful in any part of the system without indirect transmission. In this way the cost of reserve apparatus is kept at a minimum.

Layout B requires less total length of feeders and less investment in the low-tension network. No small saving in cost and complication comes from the substitution of a single operating staff for three staffs trying to work together.

These advantages of layout B, while obvious enough in the ideal case, here considered, are not usually so plain nor so completely attainable in actual cases. Nevertheless, in the long run, and when carried out with full acceptance of the principle of unitary operation, great benefits will usually be obtained.

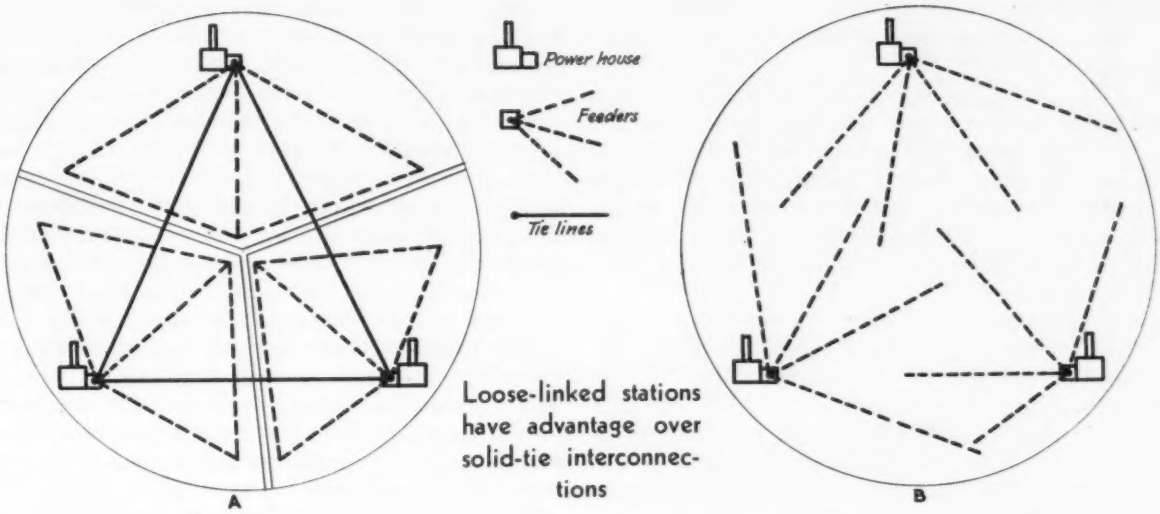
At some stage in the evolution from such a system as A to B a definite step must be taken from the independent operation of the several systems to unitary operation. It is at this point that the development is most likely to stop, as most managements hesitate to take this step. However, unitary control of operation does not in any sense require merging of the companies owning the systems. Merely a central control of the engineering layout and a single load dispatcher with authority are essential.

High-Tension Transmission—High-tension transmission line construction has become highly standardized. System stability has been investigated and analyzed most thoroughly, so the fact is now quite generally recognized that stability is the limiting factor in capacity of very long lines.

Looking to the future, certain betterments in economy and reliability are desirable. Many designs of four-leg, cantilever-type towers are not only unduly expensive but leave something to be desired in foundations, because the four-point earth bearing, in a structure of light members as rigid as these towers, is inherently sensitive to conditions during installation and to subsequent settlement of foundation. While progress on the solution of this long-recognized problem has been slow, the expedient now widely used with great satisfaction in wood-pole construction, namely, head guying, with the reduction in the number of footings to two, seems entirely applicable to steel construction except in certain areas. This method involves a return to first principles, but offers a cheap,

***April 7, 1883*—The followers of electrical science must read the best that is thought and said on the subject. The field is becoming broader every day; it is being recognized by the colleges—Cornell has just inaugurated a course of electrical engineering; Columbia and others are about to follow its example.**

***May 5, 1883*—As a matter of general interest we would state that electrical engineering departments have already been established by different institutions in the country, as, for example, the Massachusetts Institute of Technology, which will soon be ready to graduate its first class; Cornell University, and the Stevens Institute of Technology of Hoboken.—"Electrical World."**



Loose-linked stations have advantage over solid-tie interconnections

reliable and rugged construction and one capable of handling the heaviest mechanical stresses of large-capacity, long-span lines.

The importance of this consideration has been brought to the attention of engineers by the tendency of several installations of four-leg towers to fail in considerable numbers when subjected to serious wind and ice loads.

While there is a natural opposition to the use of guys, no doubt construction can be devised that will be less objectionable to land owners than some of our present lines, especially if advantage be taken of wider horizontal spacing to permit longer spans, with a resulting reduction of the number of tower locations. Such construction will permit an important saving in cost.

Efforts now being made to rationalize the status of insulation standards of high-tension transmission apparatus are timely and appropriate. The conception is now generally approved that the most effective construction will be secured by co-ordinating the strength of insulation of apparatus at various points on a line. This should be done in such a manner that high-tension surges, which may be propagated along a line, shall be definitely limited in maximum value before reaching station equipment by a prearranged lower flashover value on the adjacent portions of the line. These values should be reasonably below the insulation strength of the station apparatus.

Until the present time no very concrete results could have been expected from such proportionment, but enough progress has now been made so that a definite insulation strength against impact voltages, both to ground and between turns of windings, can be confidently offered. This affords an insulation strength adequate for most requirements.

As heretofore, it is proposed to establish certain preferred voltages for transmission systems and to design apparatus for use on these voltages in conformity with the above grading of insulation strength, the strength of the station apparatus well exceeding the maximum surge that can pass over the line near the station. A ratio of five times the 60-cycle voltage to neutral is being considered for the insulation strength level. In the case of very long lines designed to have a voltage drop favoring the power factor, it may be necessary to use apparatus for different preferred voltages on the two ends of the line.

The writer has proposed another convention in the specification of insulation flashover limits looking toward greater economy and consistency. Since the exposures to flashovers on transmission lines are of two sorts—those that exist on all towers and which occur frequently and those which are extremely rare and occur only with accidental coincidence of many improbable unfavorable conditions—a gradation of the margin of safety between them should be provided. For example, more clearance should be provided between the tower and conductor in its normal position than when it is subjected to the maximum swing. This is logical because the exposure to abnormal voltages usually occurs when the conductor is in its normal position. Maximum deflection will occur only when the maximum wind blows at right angles to the line. A high, sustained wind velocity is inconsistent with the conditions for development of lightning. Brief consideration of the numerical values of probabilities of flashover occurring in such cases will demonstrate the appropriateness of this gradation in the clearance values.

More tower clearance at normal conductor position.
Spill-gaps or capacitors for discharging surges.
Aerial cable vs. open-wire.
Cost of increased clearances and insulation retard full protection.
Protecting insulators from flashover.

It is suggested that these line insulation clearances be specified between limits; e.g., from 100 to 75 per cent, the former to be used for continuous and general exposure and the latter where the actual coincident of all the unfavorable factors in full effect is highly improbable. Intermediate values may be employed for intermediate exposures according to the judgment of the engineer. Such practice would be welcome in transmission tower design because a good many conductor hangers have been used, with extra expense and hazard, merely to satisfy a more or less arbitrary clearance rule.

A similar rule is appropriate for selecting the mechanical margin of safety.

The inherent difficulty of making really effective lightning arresters for high-tension lines at reasonable expense suggests the substitution of a spillover gap on the

line near the station, with or without a suitable arc-opening device, such as an expulsion fuse or a self-closing series breaker.

Another expedient, previously suggested but never taken up, seems to have great possibilities; that is, the loading of the incoming high-tension bus with a static capacitor, or equivalent, of such magnitude as to absorb the maximum surge from the line. Precautions would have to be taken to prevent resonance. The advantage of absorbing these surges without arcing of any kind should be obvious.

A recent development of great promise for high-tension transmission is the aerial cable, providing the charging current will not be of excessive value. When it is remembered that the reactance of an open-wire line may be four times (more or less) the reactance of a three-phase, 25-kv. cable, the inherent advantage of the cable in output capacity and good regulation is obvious enough. When it is also remembered that many of the other advantages of the underground cable are retained when it is carried on poles (such as freedom from lightning and other electrical interference, mechanical accident, insulator maintenance, etc.) and that many of the cable's disadvantages disappear above ground, the promise of this type of transmission seems greater. However, some factors must be carefully considered; for example, the effect of the high temperature from direct exposure to the sun in summer.

In the exceptional cases of super-transmission, which develop at rare intervals, there still is room for great savings by original design work. To increase capacity advantage may be taken of the fact that the reactance of a transmission circuit (usually its dominating characteristic) is nearly independent of its conductor size by using a larger number of smaller line conductors. If this departure be combined with placing more circuits on a single tower, a saving far beyond expectations may be secured.

Lightning—Lightning remains the *bête noir*, the "armed raider," of electric service. As the one source of destructive potential not arising in or co-ordinated with the voltage and power of the system, it must receive special and drastic treatment wherever it is prevalent, for it is a most serious and malignant enemy. Unfortunately, the greater part of our heavily industrialized areas is exposed to lightning. It is rather staggering that all the effort made so far has been only partially successful in eliminating the effects of lightning. The partial success is due not so much to the cost of research nor of the lightning arresters and ground wires, but to the expense of general increase of clearances and insulation strength which are automatically incorporated in practice, whether for lightning districts or not.

Led on, no doubt, by the hope that some new research would give us a lightning-proof line, our leading men among operating companies and research forces of the manufacturers have truly performed miracles in ferreting out the nature of lightning and the mechanism of its attack on the transmission line. Despite the wonderful work done, it is becoming increasingly clear that, while a great advance has been made in the control of minor lightning surges, it is not feasible with any certainty to conduct a serious direct lightning discharge down through the group of power cables on a tower and dissipate it in the ground without danger of a side flash to a conductor. The effort to do so leads to unnecessarily expensive construction and to some increase in mechanical hazard.

The problem is now being given calm and sober appraisal in search of another method of attack. Fortunately, collateral research developments and the perfection of apparatus offer the distinct promise of a solution, though much development work remains to be done. The new plan is on the side of economy and simplicity.

If it is not possible to prevent the flashover of insulators by lightning, we must render such flashovers harmless. Starting with this point of view, it is necessary to prevent the arc from injuring the insulators. This is an old problem and can be pretty well handled with horns, arcing rings, expulsion-type fuses or quick-opening breakers.

Lay out system so any link may be interrupted.
Offset reactive kva. where produced.
Means of reducing cost of load capacitors.
Cheaper rural lines.
Distribute running reserve to extend usefulness.
Don't let protective measures introduce new service hazards.
What will be verdict of future on investment in lines?

A more difficult problem is to rupture the arc following a discharge without disturbing the system. This may now be done either by an expulsion fuse in the ground connection of the insulator string or by a high-speed self-closing breaker located, where possible, in the low-tension circuit. Each device has its own field and its peculiar advantages. With the fuse connection mentioned, there is no load current to interrupt.

No doubt some difficulties will be met in working out this step in advance, but it is to be hoped that it can be developed in new construction by engineers in a position to use the most effective embodiment.

Another method of approaching this lightning problem, while suggested often, but not largely used so far, consists of establishing such a layout of circuits that any link may be spared at any time without notice. It contemplates the automatic and instantaneous disconnection of any link on which a flashover occurs, allowing service to proceed without it. This method is particularly sound since it is effective not only against lightning but against any other cause of interruption. In this plan reserve capacity is built into the system as an integral part of the whole, where it is more widely available for use.

Not the least of the advantages obtainable from the methods of handling lightning outlined (in which no effort is made to resist the flashover of a major stroke

***May 19, 1883*—In order to avoid complications likely to arise from similarity of names, the directors of the American Electric Company of New Britain, Conn., by a special act of the legislature have changed the name of that company to the Thomson-Houston Electric Company. Before many months the dynamo machines and lamps will be manufactured in a large new factory now building at Lynn. (General Electric.)—"Electrical World."**

and in which the protection comes from the suppression of the following arc in time to prevent injury to insulators and preserve synchronism) is the abandonment of the effort to build lines with extraordinary insulation strength, giving an unbalanced design. A system in which the layout is such that the breakdown of any link may be accepted without apprehension offers some interesting opportunities for less costly grades of construction. If competent reserves are provided, they should be relied upon and the margin of safety in construction should be limited to a figure that will prevent failure occurring at too frequent intervals.

This point of view is not likely to receive much favor, but nevertheless there is merit in it, because it affords an opportunity to get more value out of the expenditure involved.

Power Factor—Low power factor is one of the most insidious enemies of economy. Reactive kva. is created in every reactance in a system and the total amount must ultimately be supplied by some synchronous machine in the system. Superposition of 30 to 40 per cent reactive kva. upon the normal load kw. in a generator will not greatly increase the total kva., nor will it seriously interfere with regulation in the machine. But any further increase of reactive kva. is a load on the system. It has never been found feasible in practice to keep reactive kva. to any such low figure, but any increase results in loss of economy.

Reactive kva. should be offset where it is introduced into the system, if at all practicable, and the means of elimination should be as closely woven into the circuits as possible so that the opening of a circuit breaker will not eliminate a large protective element from operation. The most promising expedient seems to be the use of capacitors directly connected with the load apparatus. This accomplishes the two purposes mentioned and has a very low energy loss. However, its present cost, including auxiliaries, is too high for general use.

Great advantage may be secured by treating the capacitor as an integral part of every low-power factor load apparatus and omitting all protective means other than those required for the load apparatus itself. This is feasible because of the reliability of the capacitor. By mounting the capacitor within a transformer tank, for example, omitting all capacitor terminals, disconnects and fuses, and allowing for the economies of mass production, it would seem that the cost of this apparatus could be reduced to a fraction of its present price to the great advantage of all concerned.

Manufacturers and utility commissions have an opportunity greatly to forward such a program. The general increase in the power factor of electric systems to 95 or 98 per cent throughout would have a far-reaching and emphatic effect on economy and capacity.

Rural Distribution—While much publicity has been given to the subject of low-cost lines for rural service, progress to date is far short of what might be desired. It would seem that single-wire distribution, using medium-high voltages, with the transformers connected between line and ground, and with very long spans, offers great promise of spectacular saving. With a single wire on a pole the possibility of two wires swinging together is eliminated and long spans with high percentages of sag become feasible. Objection on the score of interference with telephone circuits must be considered, but the small amounts of energy involved and the lack of extended parallelism of circuits will probably prevent this disturbance being important. Such a single-wire circuit, connected to the supply at both ends, will give reasonably good service even if many miles in length.

Reserves—Reserve apparatus, while a necessity, is an unproductive expense. Something can be done to keep this to a minimum by avoiding the provision of separate spares for each link and so choosing and so locating reserve apparatus in the system that each spare will serve for as many operating links as possible. After all, does not experience show that the public will usually accept interruptions good humoredly when they occur only at rare intervals and are due to causes beyond human control?

In conclusion, it may be suggested that if the preceding discussion has fairly foreshadowed the developments of the future, there remain great opportunities for the engineer. The keynote should be economy—economy of construction and operation—for unnecessary installations made hereafter are likely to be a permanent loss and excessive aggregate system costs may prove very embarrassing in the future, when comparisons between system costs might be undertaken.

Truly to get a dollar's worth for a dollar spent should be the goal of the engineer. The economy goal cannot always be approached by following common practice. Making a fetish of continuity of service may at times lead to improvident expenditure. A high standard of service is indispensable, but in most territories the time is past when the existing standard of service is likely to lead to the loss of customers. The error to be avoided is the installation of reserves which introduce new service hazards because of the safety devices installed to care for some remote contingency. With the great advance that has been made in the reliability of apparatus now available, the omission of many local safety devices may be justified on the theory that it is permissible to disconnect a larger element of the system to gain the greater simplicity, on account of the infrequency of trouble.

Repeating the idea suggested in the opening paragraphs:

It is difficult to see how the best technical development of the industry can be secured in the more or less critical period ahead, except under the guidance of conscientious leadership—leadership having in mind not the particular problems of some local construction but the good of the industry as a whole; leadership capable of controlling tendencies and of supplying deficiencies of information or methods where necessary. Evidences of this same thought may be seen in other industries.

***August 25, 1883*—Edison Among the Ballet Girls—This from a reporter of the New York *World*, present at a ballet rehearsal in New York. "Then the spare and quite ordinary man who is moving among the girls and adjusting their corsets, is one of the dressers?" "No; that is Mr. Thomas A. Edison, the electrician and inventor." "Is he a dancing master—has he invented a new step?" "Not exactly. He has armed each one of those girls with a little battery, and at a signal each one will flash out on the stage with an electric light on their forehead. It will be dazzling."—"Electrical World."**

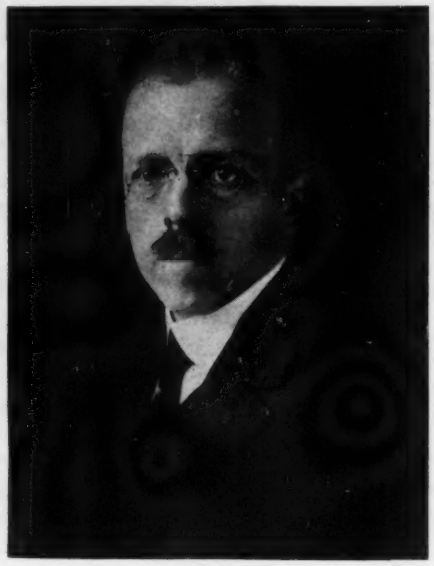
Today's Opportunities Promise Eclipse of Spectacular Past

Numerous fundamental researches only required further technical developments or economic changes to stimulate remarkable growth of commercial applications.

How some economic bars were removed

By COLIN G. FINK

Head Division of Electrochemistry, Columbia University



ELECTROCHEMISTRY had its real beginning in 1800, when Alexander Volta of Italy discovered the electromotive force of the primary cell. Volta's pile in slightly modified form was a source of electric energy that Sir Humphry Davy in 1808 utilized to pass an electric current through molten potassium hydrate and molten sodium hydrate, and to produce at the cathode metallic potassium and sodium.

Just as the discovery of Volta forms the basis of our primary cells, so, similarly, does the discovery of Davy constitute the very foundation of our fused salt industry, including the most important representative, aluminum, besides such other metals as magnesium, calcium and beryllium.

Oersted and Wöhler, 1826-28, repeated Sir Humphry's experiments and then used the potassium metal to react with aluminum chloride, liberating metallic aluminum. The price of the aluminum metal thus produced was more than $50 a pound. Michael Faraday, who was an assistant to Sir Humphry Davy, announced to the world his epoch-making discovery of electromagnetic induction in 1832, and in the year following reported upon the intimate co-relation between the electric current and the products liberated at the poles during the passage of a current through a solution of a metal salt. These discoveries of 1833, known as the laws of Faraday, are at the very foundation of our entire science and art of electrochemistry.

These laws, embodying the absolute equivalents of electrical energy and weight of metal or gas produced, have been found to hold without exception for these past hundred years.

In 1838 Becquerel recovered silver, copper and lead from their ores employing electrochemical methods. These experiments are very significant since electro-winning of copper and zinc today and the methods utilized are a realization of the dream of Becquerel. Some time later Becquerel also precipitated cobalt, nickel, gold and platinum, outlining methods of electroplating and electrolytic refining.

However, as basic and important as were the electrochemical discoveries of Volta, Davy, Faraday, Bunsen, Becquerel and others, the commercial development of these discoveries was seriously blocked, owing to the very costly supply of electric current. To find a cheaper source of power than that of the primary cell was the crucial problem at this time, for, no matter how large the battery plates, and no matter how simple the cell design, the cost of electric power was prohibitive. Faraday's discovery in 1831 of the electromagnetic current incited Joseph Henry at Albany* and Pixii at Paris (1832) and others to design and construct electrical machines, but it was not until 1871 that Gramme greatly improved upon the devices of his predecessors and built a dynamo that would operate successfully for several hours. Almost immediately the large, cumbersome battery installations disappeared.

It was the commercialization of the dynamo that gave industrial electrochemistry its greatest boost.

In 1876 the first copper refinery was built in Hamburg. Power was furnished by three "giant" Gramme dynamos. The capacity of the plant was a little more than 100 lb. of refined copper per hour, a very small output in comparison with our plants of today. At about the same time the Siemens & Halske Company erected a refinery at Oker, Germany, equipped with five dynamos and turning out approximately 1¼ tons of refined copper per 24-hour day. In London at this time William Siemens used a 4.2-hp. dynamo as a source of current for making electric steel, 10 lb. per hour, a very small beginning of the extensive electric steel industry of today.

**Silliman's Journal, 1831, page 340.*

***March 29, 1884*—A National Electrical Society. We learn that a movement has been inaugurated for the formation of a national electrical society and that several distinguished men connected with the science and with electrical enterprises have promised it their warmest support. The idea is admirable, and cannot but succeed. It is said the details will shortly be made public. (American Institute of Electrical Engineers formed within a few weeks.)**

—"Electrical World."

There is no better steel made than electric steel, and many of the valuable alloy steels of the present cannot be produced in any other way than the electric. The world's annual production of electric steel today is more than 1,200,000 metric tons.

In America Edison followed these developments in Europe very closely. The best dynamo produced by any one prior to 1878 was not more than 40 per cent efficient. Edison easily recognized the defects and shortcomings of the earlier machines and fully appreciated that they did not fulfill the requirements of a city electric lighting system as he conceived it. With his characteristic genius and perseverance he evolved an entirely new and more efficient type of generator. Although this was originally intended to produce power for electric lighting, almost immediately it became the source of power for electric furnace researches of Edison and his assistants, Edward G. Acheson and others.

Commercialization of dynamo gave electrochemistry and electrometallurgy greatest boost.

No better steel than electric—1,200,000 tons per year produced.

Aluminum production—one of largest users of electricity.

Nearly half of the world's copper production is now electrolytic.

Electrolytic copper commands premium for alloying with other metals.

The introduction of Edison's dynamo marks the great turning-point in the upswing of the American electrochemical industry.

Within a very few years after the opening of the Pearl Street station electrochemical discoveries of far-reaching importance took place. In 1886 the Cowles brothers erected an aluminum plant at Lockport, N. Y. Their process involved the electric furnace production of a copper-aluminum alloy and they employed as much as 5,000 amp. at 60 volts, which was considered at that time a large amount of energy. Aluminum oxide was placed over a molten bath of copper kept in this molten condition by the electric energy. The aluminum oxide was brought into reaction with carbon and the aluminum metal produced was alloyed with the copper in the bottom of the bowl. Charles S. Bradley, one of Charles F. Chandler's students in New York, in 1886 electrolyzed a fluoride bath of aluminum, producing metallic aluminum, and his process was improved upon by Charles M. Hall of Oberlin College, Ohio. The Hall process is the process used by the Aluminum Company of America today. Henry Y. Castner, another student of Professor Chandler, evolved a new cell, incorporating the idea of Sir Humphry Davy of using a fused bath of sodium hydrate. The sodium he produced was used as a reducing agent and aluminum chloride was converted into aluminum metal, bringing the price down to about $5 a pound.

Today the production of aluminum by the Hall-Héroult process exceeds 250,000 metric tons annually. Aluminum is one of the largest consumers of electrical energy.

The first American electrolytic copper refinery was set up at Newark, N. J. It was that of the Balbach Smelting & Refining Company. This refinery was operated successfully for more than 40 years, when it was dismantled. In 1882 the United States production of copper was 41,000 metric tons, the main producer being Michigan, with 25,500 tons. However, only a very small fraction was electrolytic.

In 1929 the annual production of copper in the world amounted to 2,000,000 metric tons, of which the United States contributed about one-half, nearly all of which was electrolytic. The United States electrolytic copper industry has become the foremost of the world, and the many plants that have been built within recent years in Canada, in England, Australia, Germany, Russia and elsewhere have all been modeled after the highly standardized and efficient plants designed and perfected by American engineers.

More than half of the electrolytically refined copper produced is utilized in the electrical industry. Copper has for years held the dominating position as the best commercial electrical conductor, but electrolytic copper, not only as a conductor but also as an alloying metal, has commanded a premium on account of its very high purity. No method of fire refining can produce a metal as pure as the electrolytic.

It is interesting to note that in the early days of electrolytic copper refining the students at the university delved deeper into fundamental principles of electrolysis, and in 1887 Svante Arrhenius of Sweden propounded his famous theory of electrolytic dissociation. It is a decided compliment to our electrolytic copper engineers that, throughout the development and perfection of the process, serious consideration was always taken of the fundamental reactions taking place. The high efficiency of the process and the high purity of the product are a direct result of the close adherence to details.

Shortly before the opening of the Pearl Street station Acheson was carrying out experiments at the Menlo Park laboratories. These experiments later led to the discovery, early in 1891, after Acheson had left the employ of Edison, of carborundum, a compound of silicon and carbon, possessing most valuable abrasive properties, and this discovery of Acheson led up to that of the conversion of ordinary coal into graphite, the well-known Acheson graphite used all over the world for electrodes and lubrication.

At the same time that Acheson was producing the first carborundum in the electric furnace Thomas Willson started the manufacture of calcium carbide at Spray, N. C., in 1891. Calcium carbide had been produced in

***August 4, 1883*—Mr. Thomas A. Edison, when questioned as to whether he intended to give up inventing and experimenting for the present, said: "I have come to the conclusion that my system of lighting, having been perfected, should be promoted, and that I could take hold and push the system better than any one else. After the right to introduce the light has been bought by outside parties, I take a contract to erect buildings, open mains, etc., and after 30 days I turn the establishment over to the local company for such money as has been agreed upon. It will take a year or more yet to complete the work of perfecting the entire system. After that is done I shall resume inventing, but just what I shall invent I am unable to say. It will be in the same line of business I am pursuing. I have heretofore found a lot of things I dare not touch. In experimenting I find a good many things that I never looked for."—"Electrical World."**

small quantities before, but it was the electric furnace that convinced Willson and his associates that the product could be made in large quantities at comparatively low cost. Almost simultaneously with Willson's work in America, the famous French electrometallurgist, Henri Moissan, was conducting experiments in his small electric furnace and produced calcium carbide. The patents in America went to Willson; the French patents went to Bullier, an associate of Moissan.

Within seven years after Willson's initial plant at Spray there were more than 100 electric carbide plants scattered throughout the United States and Europe.

Although Moissan had published an account of his electric furnace, and although many others had experimented on the design of electric furnace for commercial production, it was not until 1898 that Stassano at Turin, Italy, started the electric production of pig iron on a semi-commercial scale. His furnace consumed 2,000 amp. at 170 volts and the efficiency of operation amounted to 4,000 kw.-hr. per ton of steel produced. Then followed in rapid succession the introduction of electric furnaces designed by A. Keller, P. Héroult and others. The beginnings of the commercial production of iron alloys we can safely fix at 1901. One of the American companies, the Southern Ferro Alloys Company, located at Chattanooga, Tenn., has as its president P. J. Kruesi, a son of Edison's chief machinist.

The electric production of ferro alloys is second to none. The introduction of pure ferro-chromium, ferro-tungsten, ferro-manganese and others brought about a complete change in the steel industry. Important and valuable steels such as the high-speed steels containing tungsten, chromium and vanadium, the highly corrosion-resistant steels containing nickel, chromium and iron, are all by-products of the electric ferro-alloy industry. The metal of the Chrysler Building would be impossible without the electric furnace.

Since the day that John Kruesi in 1877 built the first Edison phonograph many improvements have been introduced, but the fundamental conception of Edison remains unchanged. Production of the disk record of today involves four distinct electroplating processes.

There are few people who appreciate that the disk record is one of the outstanding testimonials to the exactitude of the electroplating art. In spite of the repeated plating and stripping, starting with the original soft wax impression to the finished die necessary to stamp out the record by the thousands, not a single detail of the sound vibration is lost. Defects that might be present in a disk and easily overlooked are readily detected by the ear, far more sensitive than the eye.

The same fundamental exactness of the electroplating art is capitalized in the printing of our paper money and stock and bond certificates.

The electroplating art had its beginnings in America in the early years of the last century, but it was not until about 1870 that thumb-rule methods were converted into scientific procedures. It was Edward Weston of Newark who contributed so largely toward the commercialization of nickel plating. The principles and formulas laid down by Weston are today in world-wide use.

Today electroplating is an essential and important step in the manufacture of automobiles, plumbing fixtures, tableware, industrial appliances, etc. From a mere art in 1882 it has been transformed into a profession and a widely introduced industry.

Although Edison fully recognized the advantages of the mechanical production of electricity and his dynamo and lamp discoveries gave rise to the American electrical industry, nevertheless Edison fully appreciated that for certain operations and locations the voltaic cell was a necessary factor and not readily displaced by current supplied from a central station.

His conclusions have been fully realized and the primary and secondary batteries are today employed to an even greater extent than they were before the introduction of the dynamo. Edison devoted considerable time to the primary cell and his copper-oxide-alkali-zinc cell is still one of the most commonly used in railroad signal and other similar service. The lead storage battery offered a challenge to Edison and this resulted in the nickel-iron storage battery, but even as late as four years before his death Edison still hoped to find a storage battery that would deliver a maximum ampere-hours for the minimum in weight.

One hundred electric carbide furnaces in use seven years after initial plant.

Electric production of ferro-alloys second to none.

Electroplating widely used in making phonograph disks, printing, automobiles, plumbing fixtures, tableware and industrial appliances.

Electric precipitation eliminates smoke and recovers valuable by-products.

The electric discharge through gas was a subject that interested Edison from the start. At times it was a problem to avoid this discharge, notably during the evacuation of the Edison carbon lamps. The term "Edison effect" is still used today. One of Edison's associates, D. McFarlan Moore, was inspired by this phenomenon and, leaving Edison's employ, he devoted his entire time to the filament-less lamp which resulted in the so-called Moore tubes. These tubes were originally filled with carbon dioxide and nitrogen. The offspring of these tubes today is the neon tube.

Dr. F. G. Cottrell utilized the electric discharge through gas for another purpose. Cottrell in America and Lodge in England found that they could precipitate moisture and dust particles by the electrical discharge through the air or gases containing such particles.

Today electrical precipitation has become an important consumer of electrical energy and, in addition to the elimination of the smoke nuisance, has resulted in the recovery of many valuable products heretofore carried away by the winds.

Many more examples could be cited of the direct or indirect result of the introduction of the dynamo and, with it, the availability of large blocks of power.

Chemicals such as carbon bisulphide and phosphoric acid are made in the electric furnace, abrasives, alkali and chlorine and many others. In 1882 chlorine was made by a tedious chemical process using manganese peroxide as a catalyst. It was usually made wherever it was needed, as no convenient means of transporting this very corrosive chlorine gas had yet been discovered. Today chlorine is shipped in tank cars just like oil, a tank car holding 15 tons of liquid chlorine.

All chlorine today is made electrolytically.

As to the future of electrochemistry, the statement is often made that all important discoveries are a thing of the past and there is nothing that remains to be found. We disagree with this conclusion entirely. We are looking to the electrochemist to develop electrical precipitation of rain and snow and are awaiting the time when a metropolis like New York will no longer spend millions of dollars annually to combat and remove rain and snow, when all precipitation can be regulated and confined to certain geographical areas.

In materials of construction we are looking to the electrochemist to produce alloys or semi-alloys a thousand-fold stronger than steel and at the same time lighter than magnesium for our airplanes, airships, etc. What makes one metal so much stronger than another? We are learning more of the fundamental facts and are confident that the discovery is not far off of new products of revolutionary character. And why is one metal so much harder than another?

We believe that with the aid of electricity a material will be produced, just as carborundum was produced, that is even harder than carborundum and diamond. Why not?

Is copper our best commercial electrical conductor? A large-scale installation of a sodium conducting system by the Dow Chemical Company at Midland, Mich., is worth while recording. After all, must it be a solid conductor?

As to our houses and factory buildings, will we continue to construct them of bricks simply because bricks were used 5,000 years ago? Will not the next industrial center be composed of structures made entirely of metal and glass, metal consisting of electric furnace alloys and glass made in large electric mixing and melting chambers?

And when we come to mining, many of the old, tedious and painstaking methods are going to be abandoned. The recent developments in the electro-winning of copper from leached ores are pointing the way. Ores other than those of copper present new problems, but chemistry and engineering have advanced far enough to master difficulties that might be presented.

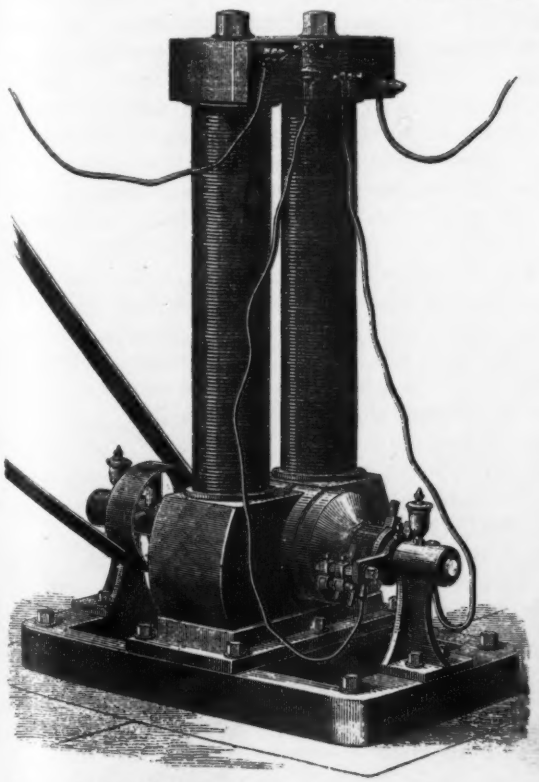
Even in the production of such delicate products as dyes and foodstuffs we may look forward to very marked changes. With the aid of electricity we can control more easily, and to a much finer degree of exactness, important factors such as temperature, circulation, etc.

Is it really necessary, in order to deliver to your door a quart of milk, or its equivalent in food or energy value, to convert sun energy into plant food, then into blood and then into milk? More than 90 per cent of good milk is water.

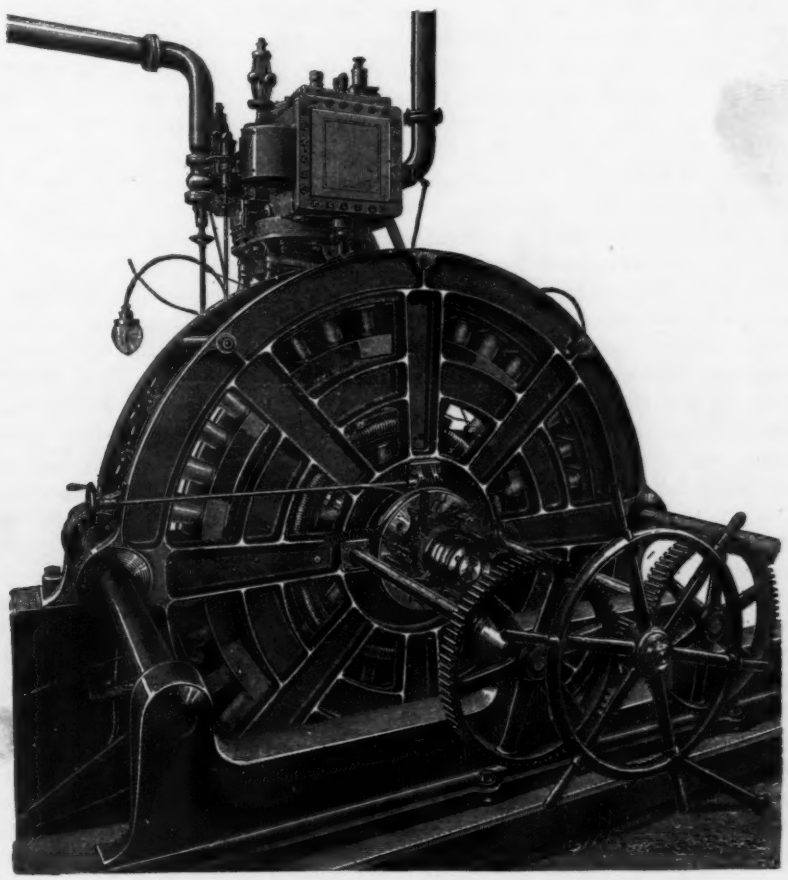
And what about power for electrical industry? Dr. Steinmetz pointed out that even if all of the rainfall were converted into electrical energy it would constitute but 10 per cent of our modern requirements in electrical energy. We must look to the direct conversion of sun energy into electric power, and our friends who have devoted their study to the photovoltaic cells are giving us a suggestion.

The future of electrochemistry, even that of the next 50 years, holds great rewards in store for us all. The young engineer will find electrochemistry one of the most fascinating fields of applied electricity.

COMMERCIAL ELECTRICAL GENERATORS



An early Edison machine, exhibited in Paris, 1882.



The first alternating-current generator (Ganz)

Distribution Progress Will Accelerate

Paths which future development may follow.
Bases for sound development.
Adapting ideas from other industries.
Compromises between system cost and utilization requirements.
Load density determines underground construction if public cost is not to be burdensome.
Primary and overhead secondary networks.

By A. H. KEHOE
Vice-President New York Edison Company

AT THE time of an important anniversary like this it is not unusual to hear expressions which are complete in their comments on the marvelous initial happening and on the related subsequent developments, but which are either void or adverse in so far as they indicate any hope or belief that future progress in the same field is likewise to be expected. However, achievements during the last half century in distribution of electric service within a central-station area may well be used to emphasize probable future advancement, as there are many promising possibilities which make it reasonable to expect that progressive changes will be accelerated rather than retarded.

Local electric power distribution had its inception with the Pearl Street system, and was so fundamentally conceived by Edison fifty years ago that the practice today has not eliminated any of his principal elements. This first complete system was epoch-making. The many subsequent developments produced means of supplying satisfactory electric service throughout our country wherever more than a few hundred people congregate. However, since such matters have been fully recorded, it is intended here to deal with the past and present state of the art of distribution as being the base on which future progress is to be built rather than to present it in its aspect of being a completed development.

The distribution system in lower Manhattan which was put in service in 1882 was designed for constant-voltage lamps which were to be supplied in varying amounts and locations throughout the district. For city distribution service the system was a masterpiece. Subsequent modifications have indeed been only minor ones when it is recalled that all of the elements which made up this system were new and had to be designed and produced from raw materials. Truly, the statement attributed to Edison, that "genius is made up of 10 per cent inspiration and 90 per cent perspiration," must have held in all particulars in so far as this square mile of underground distribution was concerned. It is related that Edison learned all phases of the gas business while perfecting his system of generation, distribution and utilization. If this be true, and it seems reasonable to believe it is, then his judgment in establishing the elements which made up his distribution system is a clear-cut case of his wonderful ability to select and apply, in an entirely foreign field, the fundamentally useful elements from some other industry and to discard the many useless ones which must also have been encountered.

Developments from this initial distribution system have been mainly in the nature of refinements. First there came additional utilization requirements in the form of motors. The advantage of higher voltage to carry energy between the sources and utilization points was promptly obtained with the three-wire system without sacrifice of the lamp-utilization voltage or the so-called "universal" characteristic of each service. Any requirement of the customer was always met at each service up to its capacity. Service with suitable characteristics, continuously reliable, and at reasonable price, was had from the beginning with Edison's system. The industry's subsequent development has been based on the fulfillment of these conditions in a rapidly changing world.

It should be unnecessary to outline in full detail the modifications which have come about during the last half century in utilization wiring and equipment, service equipment, meters, wires, cables, transformers and protective equipment. In a large part of the country alternating-current service, which was not available in constant voltage form until shortly after 1882, has been applied, but with some compromise of service characteristics and reliability to obtain reasonable price, particularly in districts where load density was low.

The cost of service for low-density distribution, combined with load requirements in the more lightly loaded districts which did not demand the same service continuity, gave rise to the alternating-current radial system which was installed all above ground. As by far the greater part of the country falls into the sparsely settled class, such overhead radial systems, with one or more reductions in voltage between station and utilization point, came to be the type commonly encountered. Costs were obtained which were commensurate with those of the Edison systems then within our cities.

It is interesting to note that there have been numerous

cases in the past where utility companies have published their requirements that such alternating-current service was to be considered temporary and that customers must change over any of their special a.c. utilization equipment which was not suitable for use on direct current at the time when the company found that the density of use would warrant the installation of the permanent direct-current system. Such policies were not illogical, considering the additional utilization requirements and the accompanying necessity for continuous reliability that came along with the greater density of use of the service. At that time such requirements could not be properly supplied from a radial alternating-current system, but could be charged direct-current system costs without being unduly burdened.

The compromise between system costs and utilization requirements which must be made in distribution, both as to service characteristics and as to service reliability, has been the cause of practically all the developments made up to the present. The problem of using public thoroughfares for system equipment has been another factor. Placing a small amount of plant overhead at any point has made it possible to supply overhead service in many districts at reasonable costs without setting up a condition which is detrimental to the public. Placing systems underground adds materially to their cost. This effect has limited the expansion of the underground direct-current system in the past to those districts which had dense and diversified utilization requirements, particularly buildings requiring elevator service and other adjustable-speed motor applications. If the load density requires a large amount of distribution plant in the public thoroughfares, then there is usually a sufficient number of the public who benefit by placing conductors, etc., underground to share the increased expense without having it become burdensome to any one. Due to long experience with underground costs and service reliability, particularly with Edison systems, the utilities are, of course, able to evaluate properly proposals to change certain districts to underground service and to allocate the accompanying increased expense when the expense can be justified.

While some utilities were expanding the Edison system whenever load densities in any overhead a.c. district justified it, others decided, after weighing service cost versus service characteristics and possible interruptions, to modify the alternating-current system in an endeavor to make it more reliable. Two of the common modifications involved: (1) Changes from radial to looped primary, with or without the tying of secondaries from groups of distribution transformers, were adopted in numerous cases to improve service to important customers or districts; (2) duplicate services, either paralleled or throw-over, were adopted in other cases. In recent years the application of automatic reclosing of circuit breakers on radial a.c. systems has reduced the number of serious interruptions very materially on numerous systems. Today automatic reclosing of distribution feeder breakers is standard wherever radial distribution is used. The use of these various modifications of the radial a.c. system was accelerated in the past two decades by the large increase in sales by the utilities of high-voltage bulk-power service.

Conflicting forces—high-grade service and lower costs.
Pyramiding factors of safety raise cost.
Cheapening construction may sacrifice service.
Load growth—greatest hope for reducing unit costs.
Demand for highly reliable service will extend.
Prospects for lowering rural line costs.
New materials needed.
Higher distribution voltages and improved service methods.

Within the past ten years utilization equipment for general alternating-current service has been developed which gives over-all service characteristics that are as satisfactory as those obtained on direct current. In the same period, also, the alternating-current low-voltage network has developed satisfactory reliability for diversified densely loaded districts. By these means the lower costs of a.c. were retained and both satisfactory service characteristics and reliability were obtained. As a result, today practically all new demands throughout the country are being supplied with alternating-current service.

At present the low-voltage alternating-current network is patterned closely after the Edison system. The universal service characteristic is had, as any service from the network will supply all standard utilization equipment up to the capacity of the service. With this system the criterion of a non-fluctuating, uninterrupted supply is obtainable at reasonable costs when compared to other systems of supply.

The remaining types of alternating-current supply systems, some of which were briefly mentioned, have recently been augmented with two important variations: (1) The primary network which utilizes several one-transformer-feeder substations with loops between stations on the stepdown side that serve as distribution feeders; (2) the overhead secondary network which, while virtually embodying the principles of the underground secondary network, is a compromise both in diversity of supply feeds and in design of secondary network.

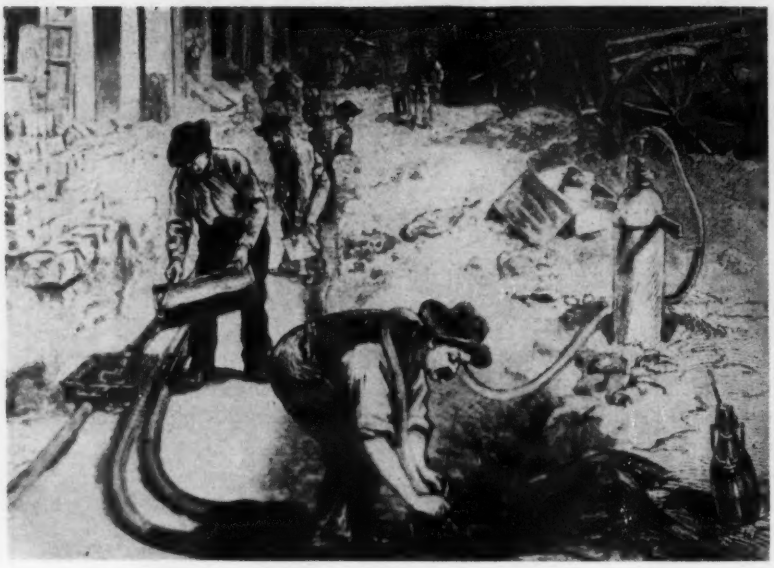
All present types of systems are being constantly

***June 30, 1883*—Mr. Edison is reported as saying in Chicago the other day: "About six weeks ago I closed my laboratory, and I have now got the system worked down to the minutest detail. There is nothing more in electric lighting to be invented or required."**

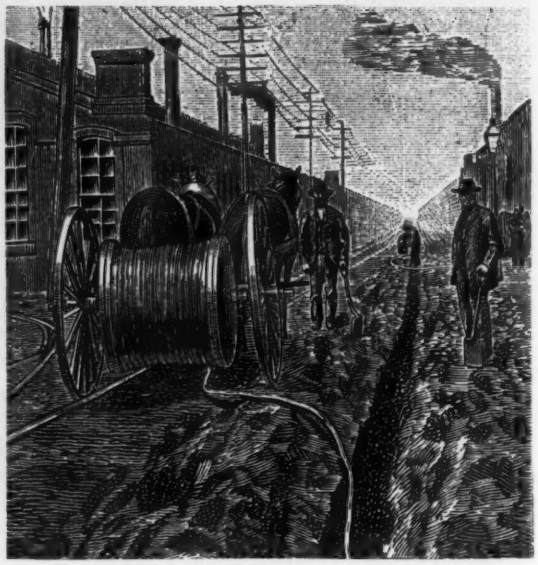
If Mr. Edison is candidly of the opinion that "there is nothing more in electric lighting to be invented or required," there is a strong probability that he will awake at no very distant day and find that the Edison system has been left behind by inventors who have acted upon his own advice, to the effect that "the best method of doing almost anything you can mention in mechanics has not yet been found out. The mind of man is so almost infinite that the field is unlimited." The truth is, there is yet much to be invented and required in electric lighting.

As we have before pointed out, however, Mr. Edison's public utterances, whenever they may have any bearing upon the commercial status of the Edison Electric Light Company, are to be received with a grain of allowance, and the present is probably a case in point. Doubtless he will himself continue to contribute to the development of electric light till it shall really and truly "shine for all."

—"Electrical World."



Laying the Edison tubes in city streets



Cable laying practice, 1884

Pole setting in 1883

pressed by two conflicting forces: one is the demand for a non-fluctuating, uninterrupted service and the other is for lower costs. There are still many cases where costs are maintained at high levels or are even being increased without materially improving the service, due to pyramiding factors of safety on equipment which by nature is radial in type of supply. On the other hand, there are certain instances where costs are so reduced that increased use is retarded by the irregularity of the service. The number of locations where quality of service becomes of major importance will continue to increase with the more universal use of the service. For instance, it is well recognized by most progressive companies that synchronous clocks alone have put interruption-recording devices onto most every service, and operating results are being noted by large groups of customers not hitherto affected. Wide adoption of refrigeration, heating and water supply which are dependent upon electric service makes interruption at all hours of major importance. If additional utilization now in prospect materializes and reduces unit distribution costs by the large amount expected, this demand for continuous service will become even more urgent.

Distribution cost has been brought into prominence during the past decade by the tremendous expansion in electric system and by the reduction in unit generating costs which have taken place. In the interval between 1921 and 1931 inclusive $2,076,000,000 was expended in distribution systems, which amount represents about 26 per cent of the total amount used by electric utility companies for total plant investment during that period. Furthermore, this large expenditure increased distribution capital investment per kilowatt of generating capacity about 46 per cent, while power plant investment on the same basis was being decreased about 13 per cent. Transmission costs have also increased, but to a lesser degree than have distribution costs.

The widespread opportunities to supply additional demands on these distribution systems with only minor in-increments in costs constitute one of the greatest hopes for future expansion and lower unit costs in the business. As long as we were rapidly expanding our service territory system costs were not lowered per unit of capacity, and there was a tendency to build in sparsely settled sections the same type of system which had been utilized in other sections having denser loads. For some time there were numerous cases in which farm service was retarded due to the cost of extensions which reflected too closely an application of urban standards to be a suitable pioneering means. The future will likely bring about demands for highly reliable service even in the outlying sections, but at present service in such territory is affected by system cost to a much greater degree than it is by an occasional interruption.

Wide attention to distribution costs has been forced upon the utilities by the increased distribution investment per unit of generating capacity installed on our systems, while other unit costs, notably those of generating stations, have declined. However, it is probable that much less public attention would have been paid to the increases if distribution costs had not been such a large part of the total costs per kilowatt-hour delivered. If

the use can be increased on each of our services, these unit costs will decline very rapidly, as high density of demand and particularly high load factor do not bring with them high additional cost, but they do represent increased kilowatt-hours use. Each additional kilowatt-hour carrying its share of the system investment and other costs of the service required, regardless of the quantity sold, rapidly lowers the cost per kilowatt-hour supplied.

Besides the assurance which we have that increased utilization per service will reduce our unit prices (since only very small increments will be added to present system costs to supply the increases), we have before us several indications that local extensions and additions of new services to distribution system are being made at greatly reduced costs compared to those experienced in the past ten years. This makes it highly probable that within areas now encompassed by our systems unit distribution costs will recede rather than increase. Considering developments now going forward in conductors, equipment and methods of disposing of these, both overhead and underground, it is hoped that, even with large increases in rural service, unit costs can be considerably lowered. Present developments have been multiplying which have utilized new materials and methods in so far as distribution practice is concerned, and there is a competitive material market which should produce new and better substitutes for some of the more expensive materials that we now have and which are now used in quantities.

The time is ripe for rapid progress, particularly for new materials, which will radically change the major elements in the system. The advantages to be gained by developments in this field are understood by many. In at least a few cases investigations, each in themselves extensive, are known to be in process in certain fields with the object of making a fundamental change in materials now in common use. It would be interesting to speculate on the distribution changes which would have taken place in the decade following the introduction of high-voltage insulation if it had not had the temperature limits now imposed on the types in common use today but, on the contrary, could be subjected to increases of 25 to 50 deg. C. above our present limits.

Besides new materials or new means of disposing of our materials, there are so many fields where changes in amounts of material required or in system design may produce further major advances that one should hardly be charged with wild guessing in predicting future advances as certain or, be credited with extreme prophetic powers in case an important advance materializes in such direction.

Such possibilities as higher distribution voltages for the future and improved methods of supplying the ever-expanding power and heating loads seem certain to be among the first subjects which will be given the review of many groups within the industry. What changes, if any, may come of this and similar activities can best be answered by the developments of the past. Many an important progressive step has occurred under circumstances similar to those mentioned.

The topics discussed are submitted to indicate a few directions in which future paths of development may lead and do not represent an attempt to pick out the developments which will be outstanding after a decade has passed. It is doubtful whether any of the paths mentioned will prove to be the most important one. It is probable, however, that experience will show much greater gains than any one could prognosticate by merely investigating some of the many detailed possibilities. Experience to date in this field has always been that way, and there seems to be the same incentives for progress that historically have proved to be essential to such progress. In this case we can reasonably expect expanding loads to occur. Developments will need to be encouraged, of course, in the future as they have been in the past. It is expected that suitable aid will be forthcoming as previously when required. We have systems which can supply non-fluctuating, continuous service, and all developments which lower the costs of distribution will react to produce a further expansion of the business.

June 23, 1883—**The latest bulletin issued by the Edison Electric Light Company states that the number of houses now lighted from its downtown station at Pearl Street is 429, in which are 10,268 lamps. The six dynamos in the station are capable of running 7,200 lamps at one time, but in an office building it is not likely that more than half of the number will be burning at the same time and in private houses the average of light needed will not exceed five or six out of a possible twenty-five. Nearly double the number of lamps now in the downtown district can therefore be connected with this station without overtaxing the current producing power of the dynamos. The average monthly increase in the number of lamps is about 500. Within the last three months Edison has made two important inventions relating to electric lighting. The first is a new arrangement of the magnets of the dynamo, by which at the same cost and with no more weight of iron and brass the result is double what it formerly was, provided, of course, that the steam power is doubled. Mr. Edison's second improvement concerns the method of distributing the current through the street mains. By the use of three wires instead of two, he is enabled to use lighter wire and save about half the expense of copper. If he had known two years ago what he now knows about stations, he could have saved, he says, 60 per cent of the large cost of the Pearl Street station. The Edison company announces that before January, 1884, there will be twenty different Edison stations in as many cities and towns well under way or in operation.—"Electrical World."**

December 27, 1884—**The Edison company have a grand central station in New York which was opened on the 3rd September, 1882, and during the whole of the period that has elapsed from that time to the date of my visit there had been only 2½ hours stoppage, that being due solely to carelessness. There are now 587 subscribers, using all together 12,764 lamps served day and night. It is interesting to know that the system is worked at a profit and that during the past twelve months the balance on the right side has been sufficient to pay a dividend of 3 per cent on the capital invested, but no dividend has yet been declared. The earnings per lamp hour are 1.04 cents, while the cost of production for the same period is 0.75 cent. The average number of hours of lighting appears to be 2.4 per day per lamp. A record is kept of every lamp so that the average life is known and it comes out at about 477 hours. The average number of lamps per subscriber is 21, while the average amount paid annually by each subscriber is £40. The difficulties that have occurred in practical working have arisen principally from a too-free use of fuses, which have given much trouble by going when they ought not to go. The conductors have unfortunately been fitted with bad joints and a good deal of annoyance has arisen from leaks in the mains; but all these effects are due to immature experience and can readily be remedied in future extensions.—"Electrical World."**

Leading with Light

By A. L. POWELL
Supervising Engineer Incandescent Lamp Department, General Electric Company, New York

THOSE familiar with the history of the electrical business can have no doubt that the central-station industry was founded because of the invention of the incandescent lamp. Edison had a device which he wanted to make and sell and had to set about building up a means of utilizing this product. In the half century which has elapsed the lighting load has at all times been the backbone and the most profitable phase of the industry. It has been this in spite of the relative lack of continued intensive selling effort.

Lighting has been the old, faithful, steady, dependable, unselfish mother in the family circle. New children have been born, some with great acclaim and receiving every one's attention for a while, only to die in infancy, or be transferred to the incubator. Others, such as electrical cooking and refrigeration, come into being, have their youth supervised by the most expert doctors and specialists and give promise of long and healthy life. Year in and year out, however, a study of the balance sheet shows "mother lighting" to be always on the job and the one to which every one turns in time of depression. As with the human family, she is accepted as a matter of course, does not receive always the respect due her, and really deserves a larger share of the attention of those dependent on her.

Since the birth of the electrical industry we have seen the invention, manufacture and application of numerous types of light sources which fall in three general groups—arc, incandescent and gaseous discharge lamps.

In the early days of the incandescent lamp one had at his disposal only a very limited range of sizes, 2 cp. (10 watts) to 32 cp. (120 watts). Now the range is from 1½ cp. (3 watts) to 150,000 cp. (50,000 watts) for use on standard 115-volt circuits. These are supplemented with literally thousands of types of special services.

For more than a quarter of a century, half the life of the electrical industry as such, practical gaseous conductor lamps, the Moore and Cooper-Hewitt types, have been on the market. Every one who appreciated the physics of light production realized that the potentialities of this method of generation were great and that eventually these light sources would come into their own. It would take some time to analyze the reasons why developments in gaseous discharge lamps have not come rapidly, and why their application is not more widespread. Briefly, there have been many technical difficulties to overcome and to date other illuminants have been much more simple in operation, of lower first cost and of equal or greater efficiency. Nevertheless, there is no doubt that we must look to these lamps for future developments.

After the Moore tubes were superseded by "Mazda" lamps, mercury-vapor lamps were left to hold the fort. These were and are still extensively used in industrial plants and fields where color values are not essential. Then came the Claude Neon high-voltage tubes and business streets throughout the world were dotted with flaming red electrical advertisements. Other gases were applied in the same manner and the Champs Elysées, Broadway and Unter den Linden present a kaleidoscopic picture of red, blue, green, violet and yellow signs. Comparatively little has been done in interiors in America, although in Paris some very interesting installations are to be seen where the tubes are concealed in indirect coves, supplemented by "Mazda" lamps in adjoining sections so that an agreeable color results.

In spite of all rumors there has not yet been produced a gaseous discharge lamp which can be screwed into an ordinary socket on commercial voltages which gives enough luminous flux to make its use feasible.

The hot-cathode lamps are constantly being improved and, while still rather complicated in design and requiring a considerable amount of auxiliary apparatus, hold great promise.

A number of successful and pleasing luminaires have been constructed in which the green mercury vapor tube is combined with "Mazda" lamps. The colors supplement each other and a very agreeable and relatively white light results.

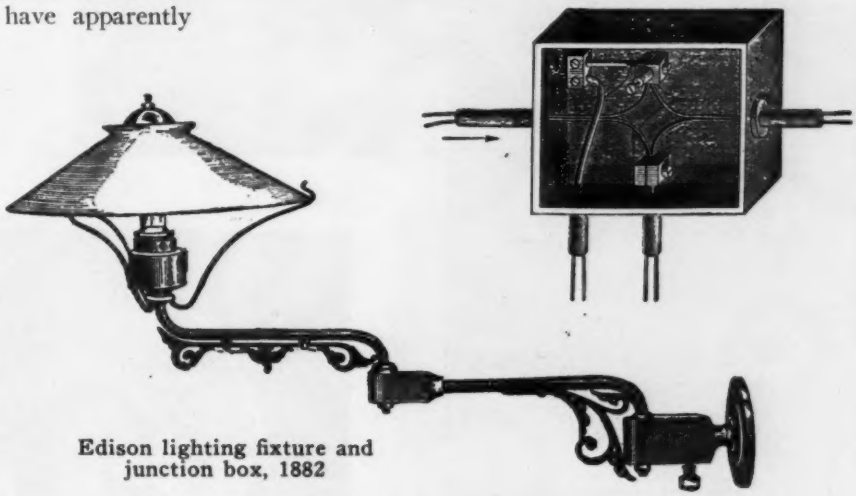
The sodium lamp offers a means of providing flux in an extraordinarily efficient manner. Many difficulties stood in the way of making this lamp—ordinary glass is attacked by the vapor and it is necessary to keep the bulb very hot, but research seems to have overcome

February 24, 1883*—(Prof. N. H. Edgerton, Franklin Institute) "I've been sunburnt by electricity. I have had my skin peel right off from exposure to that light over yonder. Of course such an effect is only produced by near proximity to the light. The spectrum of the electric light and of the solar range are precisely the same, and although differing in intensity, there can be no difference in the effect. A thin pale girl accustomed to working in a close dark room will grow ruddy and strong under electric light. Plants thrive under it. For downright healthy illuminating power, give me electricity."—*(Arc light.)
—"Electrical World."**

these. Unfortunately the strictly monochromatic yellow light makes all colored objects appear as different shades of gray, so the effect is very unpleasant. There seems to be no general use for such lamps save for street lighting, in which field there is now an experimental installation in Holland.

There is absolutely no indication that in the near future there will be a light source available which will supplant the "Mazda" lamp with its simplicity, low cost, high efficiency, wide range of sizes and pleasing color of light for general illumination purposes. Of course, there is always the possibility that some unknown experimenter may make an outstanding discovery, but the latest advices from established laboratories do not reveal anything under consideration which can be expected to fill the general field.

Interior Illumination—Except for a few cases of cove and indirect lighting, most designers have apparently found it expedient to copy the types of luminaires used for flame sources, candles, gas and oil. The first electric fixtures were practically old gas chandeliers with bulbs in place of the burners. Decorators had the feeling that the ideal in decorative lighting was to make an exact replica of some candlestick fixture for pendants or brackets and use the twisted bulb lamp instead of the tiny flickering flame. The practice is fundamentally wrong. The artists who created these designs would never have done so if "Mazda" lamps had been available; they had too much good taste and common sense.



Edison lighting fixture and junction box, 1882

Fortunately, within the last five years a change for the better has taken place and the more intelligent architects and designers are providing modern electric lighting. Modern lighting equipment is that sort which permits a modern light source, such as the "Mazda" lamp, to function effectively. It can be successfully applied to any sort of period interior, provided that it carries the spirit of the period in its lines and has detailed ornamentation which is closely associated with the style being followed.

So-called "built-in" lighting is comparatively new and we have naturally seen some horrible examples of what not to do. In some instances glass has been used which gives inadequate diffusion, resulting in a spotty effect. In other cases the mechanical construction features are deplorable, making it difficult to relamp and clean the equipment. Many installations give the appearance of having been designed by a tinsmith or boiler maker with no sense of proportion or knowledge of the most simple fundamentals of beauty. Nevertheless, the practice is growing and each new installation adds to our skill and marks a step forward.

The bizzare methods, which started as a revolution against slavish imitations of antique luminaires, will disappear through evolution. The first motor cars, too, were far from the graceful ones now on every hand. There is no doubt that all important buildings of the future will have lighting equipment as a component part of the design rather than taking the form of "fixtures" which are hung up at the last moment for the sole purpose of furnishing something to see by.

Fear has been expressed in certain quarters that built-in lighting may become tiring and, being part of the structure, cannot be changed. If the design is sound and pleasing, there is no reason why an artificial lighting arrangement should be any more monotonous than a natural lighting device; e.g., a window. Although easy to change the old style luminaires, how often was it done, even though they were antiquated, displeasing and inefficient? The name "fixture" is and was literally true in most cases.

Styles in lighting change every few years. It is well for the fixture industry that this is so and there are many more engineering reasons for changing styles in luminaires than we find in that outstanding style business—women's wear. If the fixture industry can convince the public that new styles are really better and more suited to the latest developments in lamps, its business should not be stagnant, but holds marvelous opportunities for development.

The illustrations on pages 460 and 461 indicate what progressive architects, engineers and designers are doing. At last there seems to be a general appreciation that artificial light is one of the most useful decorative mediums. It is a real inspiration to make an

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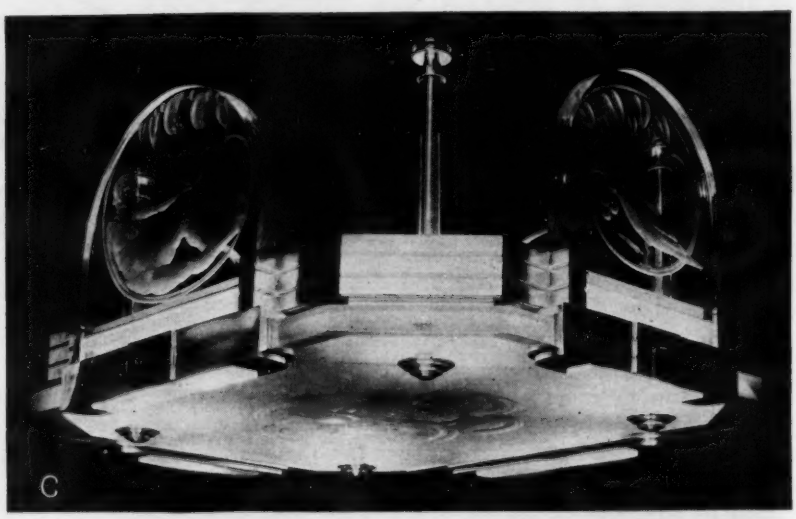
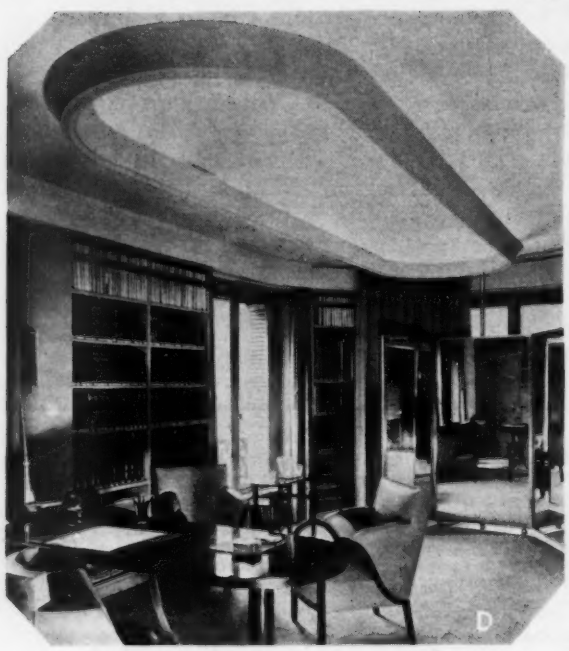
December 1, 1883—**In no place is good artificial illumination more imperatively needed than in the workshop, the mill and the pressroom. All establishments of this kind are busy during the fall, and the proprietors are now driven to the consideration of the best means of supplying the men with light. It may be claimed without any rashness, we think, that the electric light is in the greatest favor with them, and is rapidly superseding gas, on the ground of efficiency, economy, safety and cleanliness. Manufacturers find that they derive more profit from the labor of their men when it is performed with the aid of a steady, uniform and powerful electric light than when they depend upon any other means of illumination. We are glad to know that the progressive spirit of the age has not stopped in our shops with the introduction of improved tools, but is extending also to the comfort and convenience of the workmen as well.**

—"Electrical World."

Diversity of





(A) This private office, very modern in decoration, has luminaires with which both direct and indirect light can be obtained. Their design is in keeping with the other decorative features.

(B) This section of a small exclusive shoe shop is lighted by three rectangular luminous boxes grouped together and mounted close to the ceiling. The illuminated showcase and the mirror (partly shown in the lower left-hand corner) with its concealed lamps to light the shoes which are being examined are worthy of note.

(C) Truly beautiful combinations of polished metal and carved glass have resulted from the new approach to the design of luminaires. One instinctively feels that they are intended for use with electric light rather than being an adaptation of old forms.

(D) In this combination library and private office in a Paris apartment totally indirect lighting is supplied from lamps hidden in a suspended composition trough, so designed as to follow the contour of the room.

# of Modern Lighting

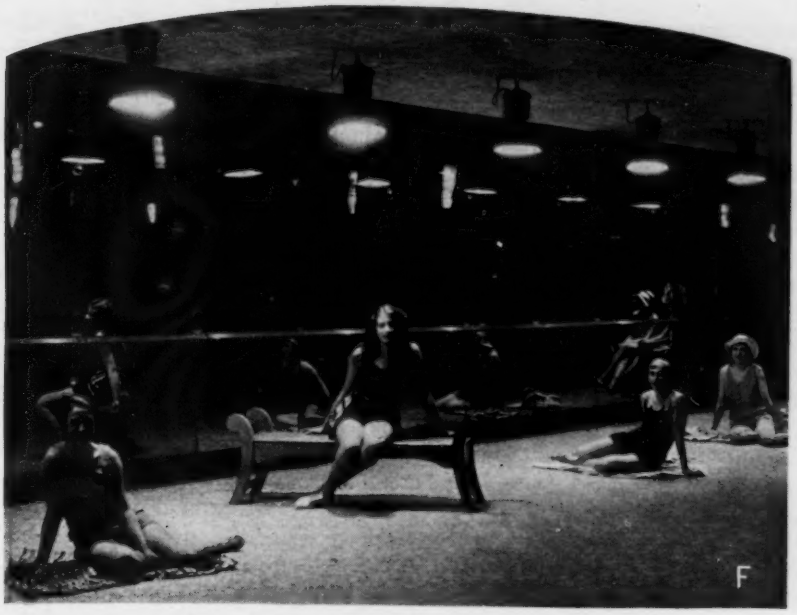
(E) A semi-indirect wall luminaire of decorated china which is efficient and pleasing. It is well suited for use with the high-powered modern "Mazda" lamp and much more logical than the old-style bracket.

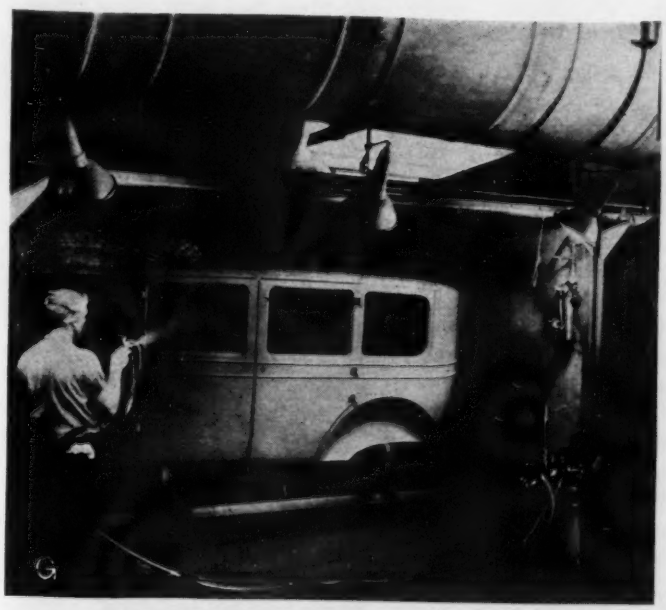
(F) The bathers at this swimming pool disport themselves under sun lamps, receive ultraviolet radiation and thereby maintain a winter coat of tan through the winter.

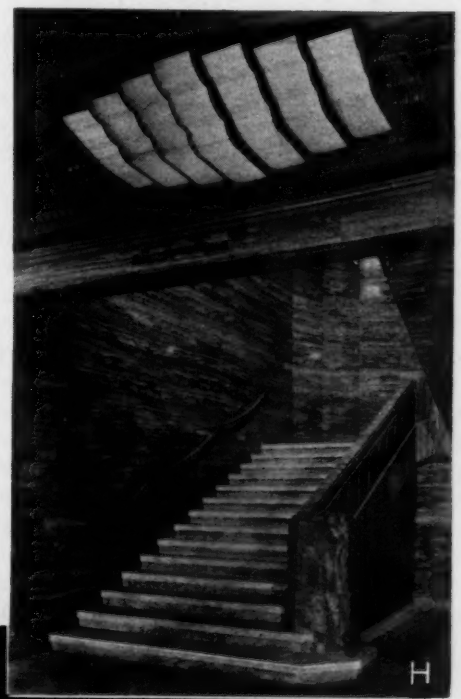
(G) In this industrial plant a suitable level of general illumination is now supplemented by projectors and other devices which provide high level lighting over working areas.

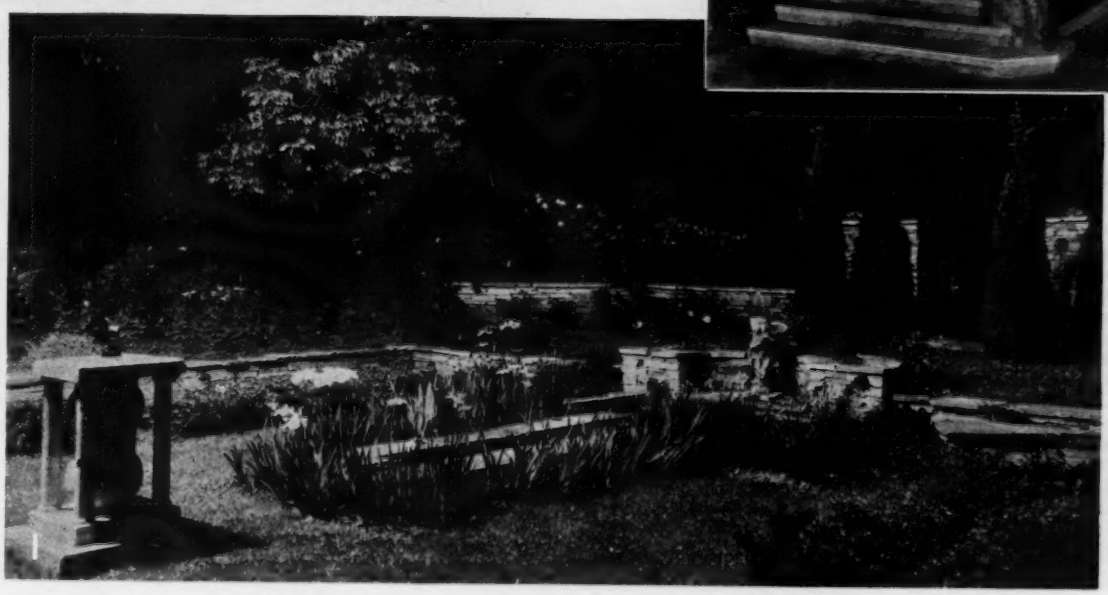
(H) In the entrance to the Los Angeles Stock Exchange with its massive stone treatment this built-in luminaire following the lines of the molding is much more appropriate than a rather insignificant hanging chandelier or lantern carried down from the torch, candle or gas light age.

(I) One or two skillfully placed projectors reveal the beauty of a garden at night and create a fascinating picture with brilliant contrasts of high lights and shadows.









inspection of new buildings and see the many novel ways in which light is being used. The artistic element is being combined with engineering or scientific features. When the new movement in lighting started the fixture industry was greatly upset, believing that any machinist or tinsmith would be in a position to compete with it. Such has not been the case. The best work has been done by those designers who have the background of tradition and who have taken advantage of the most recent discoveries in the utilization and control of light.

For years we have heard the expression painting or decorating with light. It seemed to be a good idea, but nothing was ever done about it. Now we find a number of practical operating installations, not merely demonstrations in some laboratory.

The fundamental idea is to make the room quite simple in design and light in color to reflect well and then with controlled light supply the decorations. Sometimes this is in the nature of simple color effects, as in the Salvation Army Auditorium, New York City. The colorama exemplified in the Hotel St. George, Brooklyn, uses changing colored shadows. The ceiling of the auditorium at the Juilliard School of Music at New York is absolutely plain, but has thrown on it symmetric shadow patterns from cutouts placed over the lamps in indirect fixtures. The Bal Tabarin in Chicago uses the Clavilux, invented by Thomas Wilfred. Sweet's Persian Gardens in San Francisco combines colorama with light patterns of flowers, foliage, and the like. Les Miracles, a cinema in Paris, covers the curtain and the two side walls with scenes projected from powerful lanterns. The Staley Building at Decatur, Ill., has its exterior floodlighted with softly changing color effect.

To obtain colored flux from the "Mazda" lamp it is necessary to screen out that portion which is not desired, so in spite of the high intrinsic lumens per watt the production of colored light by this method is relatively inefficient. The gaseous conductor lamps are very efficient producers of colored flux. This highly colored light is an objectionable feature for most uses, but in decorative lighting, where color effects are important, offers a field which has scarcely been touched. One can visualize a large auditorium, or other monumental interior where the ceiling is made of a series of coffers or glass-covered boxes in geometric arrangement. With the intelligent application of red, green, blue and yellow tube lamps, the whole surface becomes a brilliant, glowing mosaic. The flux on its downward path mixes and the resultant illumination is quite satisfactory in color quality. Luminous luminaires on the same principle also offer numerous potentialities. In Paris one finds some very agreeable installations where the ceiling is covered with a series of indirect troughs in which incandescent lamps, purple and red tubes are used to secure very artistic effects.

More than a decade ago it was definitely proved that the higher the level of lighting in the show window the greater the attracting power, and the standards of window lighting have constantly risen, as more and more merchants became aware of this relationship. Increasing levels of street lighting have also stepped up the window lighting for there must be a contrast between it and the surroundings. A window in a dark side street with a small fraction of the wattage per running foot is as effective as the very bright window on the white way. In spite of all the publicity that has been given to the fact that the show window is a miniature stage and should use the color, direction and spot effects used in the theater, really very little has been done along this line. There is a field for a stage technician if he were given a free hand and supplied with the necessary apparatus. A striking display properly lighted has nearly 100 per cent drawing power. There is now scarcely one show window in a thousand in which full advantage is made of what light might do. Stage lighting is bound to be applied to the show window at some date.

In the early days of study of the effect of light on the eye most tests were conducted with black objects on a white background, which gives maximum contrast. The conclusions derived from these tests were accepted for several years. Later more careful analyses, however, have shown that in much of our work the contrasts are of a low order, as produced by black on gray and, therefore, in planning lighting we must not be governed by experiments which are conducted under less exacting conditions. Where we once believed that 10 foot-candles, for example, was adequate for a certain class of work, investigators are now convinced that 100 or 500 foot-candles may be desirable.

Less than twenty years ago an industrial plant was considered quite well lighted if the average level of artificial illumination was in the order of 2 foot-candles. Now such a degree of illumination would be acknowledged by every one to be far too low. The modern plant is providing from 10 to 20 foot-candles of general lighting. Since tests and experiments have shown that for many processes more than 100 foot-candles is desirable from the standpoint of speed of vision, accurate work and minimum fatigue, the question arises, shall we light the whole plant to this level? The time may come when factories will be thus illuminated, but at present it seems desirable to supply from 10 to 20 foot-candles of general lighting and supplement this with intensive illumination at critical working points. This is not being done with the old style drop lamp or portable, but by suitable projectors located in strategic positions which build up the illumination where needed. This light must come from the right direction and be so arranged that extreme contrasts and reflected glare are avoided.

Largely through the activities of central-station light-

***October 13, 1883*—The Incandescent Conductor. As our readers are aware, a question of priority as to the effect of an incandescent conductor for an electric lamp formed of carbonized paper has been pending at the patent office. The dispute is between Sawyer and Mann against Edison. A decision in the case was rendered on the 8th instant at Washington by the Commissioner of Patents and is final so far as the Patent Office is concerned. Mr. Edison loses the case there, but he can, if he desires, appeal to the Secretary of the Interior. The question is an important one as a contrary decision would have given to Mr. Edison the sole control of the manufacture of carbonized conductors. Commissioner Marble is of the opinion that the conductor, of which Edison claims to have been the inventor, and the Sawyer and Mann conductor are substantially the same and that the testimony shows that Sawyer and Mann had the conductor in a rude form in March, 1878, and in a perfected form in September or October, 1879, while Edison did not have his conductor perfected until October, 1879.—"Electrical World."**

***July 28, 1883*—Mr. Edison's Patents. During the week ending July 17, five patents were granted to Thomas A. Edison for improvements in electric light and power machines. "When that man dies they will miss him at the patent office, if they don't at home"—"Electrical World" quoting the *Cleveland Leader*.**

ing service men throughout the country new school buildings are now fairly well lighted, but there still exist thousands of buildings erected twenty or thirty years ago which are a disgrace to the community as far as lighting is concerned. A strenuous effort should be made to correct this condition in order to conserve the vision of the growing child. It is at school where he just begins intensive use of the eyes and permanent injury may result from forcing their use under inadequate lighting.

From strictly economic considerations, windowless buildings are indeed feasible. It can be proved that through the saving in cost of constructing windows, decreasing of radiation heat losses and greater ability to control atmospheric conditions one can afford adequate artificial light at all times rather than daylight.

Nevertheless, it is doubtful if this practice will meet with popular favor. The most efficient and scientific of us prefer daylight, even though we may know that ordinary window glass absorbs the health-giving ultraviolet portion of sunlight. We like "fresh air," and even in those industrial plants where air conditioning makes the atmosphere better and cooler than out of doors, if the workmen are not very carefully watched, they will open windows on the dusty, humid street. It is true that in the cities, in particular, we might supply false windows behind which were placed attractively arranged, well-lighted pastoral scenes and really make the whole effect much more pleasing than it now is and, possibly, this will come in the future.

The supplying of artificial ultraviolet radiation is a comparatively new project and this has recently received so much publicity in the technical press that one cannot justify a complete discussion in the available space. It is sufficient to say that its field is apparently unlimited, although as yet we do not fully appreciate all the factors involved and have not definitely determined the laws governing its use and the effects. The evidence so far accumulated indicates that the health-maintaining properties are such as to justify the increased cost of installing and operating a system which supplies this radiation. In a number of offices the clerks are exposed to the radiation for definite periods each day; some school installations are in service; in certain factories the operators are compensated for their inability to be out of doors; babies' hospitals have their treatment rooms; many swimming pools offer the opportunity to receive an indoor sun tan; some lunchrooms feature the fact that you can be exposed to the radiation while eating; many animal and poultry farms are using ultraviolet as a measure of economy, and numberless homes have sun lamps in the bathroom and nursery.

Exterior Illumination—If our auto traffic continues to increase as it has in the past there is no doubt that economic considerations and safety will force the introduction of highway lighting of the main arteries of travel. This must be such that auto headlights will not be required, for the best of these are always accident hazards. It is interesting to note that in Europe, where the traffic problem is nothing compared with ours, highway lighting is receiving more serious consideration than in the United States and definite projects of considerable magnitude are now under way.

Improved street and highway lighting is a legitimate part of county or state road expense because it has been determined that there is a very definite relation between street lighting and automobile accident. The Travelers Insurance Company, which cannot be accused of having a selfish interest in the sale of electricity, is on record that there is an excess number of automobile accidents in winter due to insufficient light, with an economic loss in winter over summer for the country as a whole of $200,000,000. Similar statistics are available which show the decrease in crime when improved lighting is installed.

A field which today has scarcely been scratched is garden lighting. It is simple and inexpensive to install, artistic in its effects and a source of joy to the owner. It gives play to the imagination and one's inventive ability. The type of man who is interested in his garden is just the sort to get much joy from experimenting with its lighting. The indirect effects of this are valuable, for they develop a new sense of "light consciousness" on the part of all who see what charming pictures result from skillfully applied artificial light. An adjunct to this might be termed the "police" effect of lighting the grounds. Suppose a single projector is located under the eaves of the house directed toward some chosen bit of beauty, a noise is heard in the neighborhood, the switch is thrown and the direct and spill light instantly reveals the source of the disturbance.

This line of thought leads one to mention the advisability of having the interior lighting on a master switch for the same purpose, and the protection afforded by a low-wattage porch lamp left on all night; the criminal always avoids light.

In the lighting of sports some of the most striking advances have been made. Lighted tennis courts were a novelty fifteen years ago, now they abound on every hand. Night baseball has been the salvation of the minor leagues. Night football has brought thousands of dollars to the coffers of the smaller universities. Some golf courses are already equipped for night play, and if normal times return, requiring intensive daytime work at the office, this practice will surely spread.

Floodlighting of public buildings, monuments and

***October 6, 1883*—A correspondent of the London *Times* at the Vienna Electrical Exposition writes: A most important advance in incandescent lighting is for the first time practically illustrated on a large scale at this exhibition. It is the possibility of turning on or off any number of incandescent lamps in one circuit without any special apparatus for the regulation of the current. This is done by means of the compound dynamos, whose principle I have shortly described in my previous letter. By a simple manipulator, fastened to the wall near the machine any number of incandescent lamps can be short circuited. How important this is will easily be understood on reminding your readers that all the incandescent systems, Edison, Lane-Fox, Maxim and Swan, have special apparatus for this purpose, all based on the principle of introducing a greater or lesser resistance into the circuit. These special apparatus are no longer necessary and a great saving is thereby effected.—"Electrical World."**

other objects of interest is a comparatively new thing. The first examples were rather inartistic due to reversed shadows and lack of subtlety. The technique, however, has been developed to a remarkable degree and the most recent installations cannot be criticised from the artistic standpoint. The progressive architect is realizing that his buildings will probably be lighted at some time in the future, and he is planning accordingly. He gives consideration in his design to providing suitable mounting spaces for the projectors and arranges his ornamentation so that it will appear well by night as by day. The "Selsyn" thyratron control has been applied to this service with great success and delicate, slowly changing color effects are the order of the day.

Closely allied to floodlighting is the new practice of decorating the entire building with light. The "built-in" effects which originated in interiors have been successfully applied to the exterior. Luminous boxes, panels, niches, parapets and other ornamentation are to be seen in the most recent structures. Among the interesting examples are the new Mohawk Hudson Building at Syracuse, the Northwest district office of the Philadelphia Electric Company, the Bal Tabarin at San Francisco and the showroom of the Studebaker Corporation at Chicago. This procedure is unquestionably the most dignified form of electrical advertising, and in the mention of this one thinks of the electric sign itself.

In the early days the blue and white enameled signs were probably the most ugly things which have ever been built in a civilized land. How civic pride was so little evident as to permit their widespread use one cannot understand, but evidently the electric sign had sufficient inherent merit so that it survived this terrible beginning and became universal in its application. Fortunately, the artistic standards of sign design have been vastly improved, although there is still much to be done. The wide-awake architect, in spite of any personal antipathy he may have toward electrical advertising, now realizes that the building owner or tenant will no doubt install a sign. He therefore arranges his elements of design so that the sign can be applied to advantage and in many cases actually works out the details himself. It would be impossible to list the numerous developments which have been applied to the electric sign for every few months shows us something new, such as the sequence circuit control which has just been perfected.

Light Control and Wiring—The perfection of light sensitive tubes or cells has placed a new tool at the disposal of the lighting industry. These devices are so relatively new that we have not yet had an opportunity to discover their full potentialities for controlling lighting automatically to compensate for variations in daylight. A few installations have been made in school rooms so that the busy teacher with her mind on many other matters will not forget to turn on the artificial light when the natural lighting has decreased to a predetermined point. Some industrial plants use this control for the same purpose. A number of large signs are also wired so that they are lighted if a sudden storm makes the streets dark and when night falls. It is not at all improbable that the future will see remote sections of street-lighting circuits functioning in the same fashion.

A very ingenious light-measuring device employs the "photronic" cell instead of the old style photometric head in one of its many modifications. It has always been difficult for the layman to be shown the means of measuring light or illumination. There seems to be some mystery about a photometer that he cannot understand. In the new instrument, however, the reading is indicated on a meter similar to the ammeter of his automobile dashboard—this is something he understands. The new photometer has been very successful in demonstrating effect of voltage on light output, the necessity for replacing blackened lamps, etc., as well as for the measurement of illumination in offices, stores and workplaces.

No story on lighting would be complete without mention of a phase of the electrical problem which has caused much difficulty in recent years. This is inadequate wiring. In the days of the carbon lamp, even though the levels of illumination were not high, the lamps were so relatively inefficient that most buildings actually had relatively heavy wiring. The "Mazda" lamp superseded the carbon lamp, and with it the standards of illumination rose by leaps and bounds. For a period there was enough copper in those buildings wired for carbon lamps to take care of the advancing standards. Gradually, however, designers began to figure wiring based on the more efficient lamps and, unfortunately, the greater majority of estimators take the Underwriters' code as the standard for wiring. They fail to realize that this is merely a safety code and is not intended as a guide to good practice. As a result, many of our modern buildings are ill-equipped to meet the demands of their users. There is not sufficient wiring to carry the load which is today recognized as standard, and certainly no provision for the future. In many cases the voltage drop is excessive, causing lamps to operate very far below their normal output and aggravating an already bad condition. Inadequate wiring is the greatest handicap to lighting development of the future.

Fortunately, the industry has now begun to appreciate this situation and active campaigns of education are now being conducted by the N.E.L.A. and I.E.S. and other interested bodies. If we are to continue to "lead with light" there must be sufficient copper installed so that the current can reach the light sources unimpeded.

On the whole, a new mental attitude can be observed on the part of those designing and planning lighting. There is a much greater appreciation of light for its decorative value. The question of efficiency is not as strongly emphasized as a few years ago. Light has become so relatively cheap that we can afford to sacrifice a certain amount if a better appearance results. The illuminating engineer is becoming more the artist and thinking less in terms of the relation of effective to generated lumens. If a given system has nothing to recommend it but efficiency, it is out of the question for an artistic interior. On the other hand, if two systems are equally pleasing and one permits the obtaining of more light for a given expenditure, it should be chosen.

***January 26, 1884*—Some months ago the city authorities had a number of electric lights placed in Military Park (Newark, N. J.), thinking that they would beautify it and render it attractive to the people. The effect has been remarkable. The park being well lighted, the disreputable characters now carefully avoid it, and the park has been entirely free from the many objectionable features previously existing.—"Electrical World."**

Manufacturing for Profitable Sales

By J. S. TRITLE
Vice-President and General Manager
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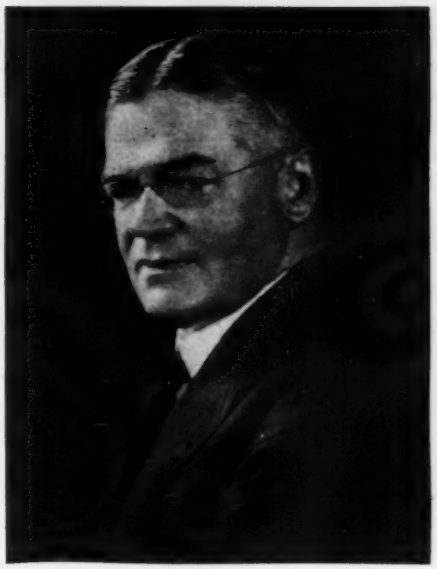

Current trends and problems.
Class of products and organization to produce and sell.
Consumer market development needs serious attention.

WHEN the Pearl Street station started operation in 1882 electrical manufacturing was limited to the production and sale of arc-lighting and electroplating equipment and the total annual sales were about $5,000,000. Yet in 1929, according to the U. S. Census, the value of electrical manufactured products at factory prices aggregated $2,286,273,000. Even in 1932 the total sales value of electrical products is only slightly under $1,000,000,000 despite a general decrease in primary industries to 15 to 20 per cent of 1929 levels. Yet, despite this rapid expansion of the industry, even today the market is unsaturated. Consumers now own electrical equipment, wiring and devices aggregating some $14,000,000,000, yet conservative estimates show that there is an additional market available of approximately $21,000,000,000, without considering prospective developments such as air conditioning.

Statistical facts such as these make up the enviable record of the manufacturing branch of the industry and indicate a very encouraging outlook for the future. But the success of the industry depends primarily upon its man-power and its organization. It depends upon human beings and their ability to organize, to produce and to sell in an ever-changing yet always competitive marketplace.

During the past ten years electrical men have made a splendid record in the consumer market. In 1919 the total consumer expenditure in this country was $72,811,566,000, and of this $746,000,000 went for electric appliances, light and power and the telephone. In 1930 the total consumer expenditure was $90,172,167,000 and the electrical industry received $2,045,514,000 of this —a greater percentage gain in the competition for the consumer's dollar than was obtained by any other industry. Yet in 1930 the consumer spent more for recreation, or for health or for personal items than he did for electrical products and services.

Thus, despite the progress to date, the consumer market still affords the electrical industry a business of enormous magnitude under enviable competitive conditions because of the salability of electrical products and services. Can the industry meet the challenge of this opportunity?

Electrical manufacturing consists of production, distribution and sales with associated activities in research, engineering, finance, accounting and the many other activities of modern business. The ability of the industry to expand and to sell the markets depends upon how well these activities are directed and how effectively the enterprises are perfected for correlating all efforts so as to reach the markets and sell them. Undoubtedly both the low volume of present business and the economic and social changes introduced in the past few years make this an opportune time for a critical and constructive survey of the electrical manufacturing business. It can be improved and it should be.

Only one aspect of manufacturing is the production of products, and at present this may be divided into three divisions:

(a) Mass production of standardized equipment such as motors, transformers and lamps.

(b) Specialized engineering product manufacture such as controls, turbo-generators and high-tension switchgear.

(c) Production of household market devices such as electric appliances, wiring supplies and radio.

In each of the production divisions the development of new and better products must be considered, commercial and technological obsolescence is a threat at all times and each plant and production process must conform most economically to both marketing and manufacturing changes. One maufacturer may make one or all of these products and very keen competition exists between the manufacturers, with the result that from three to twenty independent enterprises may be trving to sell the same purchaser.

***October 27, 1883*—The Edison Electric Light Company has begun preparation to quadruple the capacity of the downtown station in Pearl Street, near Fulton, by filling the adjacent building on Pearl Street with new dynamos. Owing to improvements made by Edison during the last six months, a new plant no larger than that now in the station, which is of six dynamos, will do three times the work. There are at present 12,000 lamps in the district connected with the station and an average of 1,400 lights burning all the time, the number rising to 5,000 on dark days and late in the afternoon.—"Electrical World."**

It is very apparent that the manufacture and sale of mass production products in future will be made upon the basis of competitive merit through the free play of price, quality and consumer demand. It is apparent that each market area must be studied to see whether a plant in each region or a single large plant for the national market is the more satisfactory. It is necessary to study discount, time payment and delivery conditions and to develop co-operative industry policies to get fair and healthy competition and yet have stability with respect to these practices. It is important to consider the factory more critically, so that a machine production and assembly line is the basic manufacturing asset instead of beautiful but expensive factory buildings and grounds. It is necessary to reach open agreements with competing manufacturers upon standardization processes, cost-accounting methods and statistical information about production. Moreover, each enterprise can no longer play alone in the market. It must adapt itself to existing commercial conditions and must take full advantage of the opportunities for team-play sales with other enterprises so that competition is informed and fair and so that a stable and profitable approach is made upon the markets. Mass production calls for the keenest possible skill in manufacture and the closest possible co-operation between competing units so as to establish sound practices.

Specialized engineering product manufacture is another aspect of the business. Essentially each sale is the result of an engineering analysis and each product is a special design. Patent controls are major business assets. Technological skill is one of the greatest sales aids. This type of manufacture, therefore, does not lend itself to mass production processes in either manufacture or sale. Many small enterprises are in this field, and yet departments of the large manufacturing companies also engage in this class of business. Here again the growth of market area plants must be studied and the most efficient factory design must be obtained, but there is little opportunity for co-operation and standardization. Possibly the most difficult and expensive aspect of the business lies in the enormous amount of free design and engineering service rendered each buyer by the competing manufacturers. Some co-operative industry study should be devoted to reducing this cost to the benefit of both manufacturer and purchaser. Undoubtedly, however, specialized-product manufacture will grow and expand, for it is the new idea and new invention type of productive enterprise that stimulates industry progress.

With respect to both mass production and specialized engineering product manufacture the industry is fairly well organized and has its problems well in hand. Such marked economies have already been made by the use of mass-production equipment that great economies are not in view at the present time for the future because material and labor constitute such a large percentage of the sales price. But engineering and manufacturing departments of electrical companies are studying this problem incessantly so that even in such lines as motors, meters and transformers economies may be effected in the future.

It undoubtedly is true that both large and small manufacturers can exist and prosper in this business as the small manufacturer has certain advantages of intensive

***August 16. 1884*—There is no doubt, even should the depression in financial and commercial circles be prolonged, the electric lighting business has seen its worst days and is now entering upon a period of rapid growth and large profit.—"Electrical World."**

specialization in production and sales that offset other advantages held by the large manufacturer. This class of business is operated on small profit margins, and a small gain resulting from an improved design or an improved manufacturing process can be capitalized upon readily in commercial activities so that progress under the spur of competition is maintained.

However, it is in the realm of consumer or domestic market products that the industry can make most improvement. This is the most complex division of electrical manufacture as regards both production and sales. Yet this consumer market offers the industry one of its largest business opportunities. The market for electrical appliances and wiring in the homes of this country, for example, is estimated to be at least $12,000,000,000 at present and it is expanding rapidly.

This class of business has grown by stages to its present magnitude on the basis of the production and sale of a single appliance or product by many manufacturers. Style elements, new materials, new manufacturing methods and new products have characterized the growth of the business so that little opportunity has existed for stability, standardization or mass production. Each new device has been introduced to the consumer market at great expense, it has been manufactured and sold as a specialty product and then has gone through the successive stages of pioneering, specialty selling and dealer selling, while at the same time it has undergone production and design changes. Wiring and wiring devices have had even a more difficult commercial path because they have only indirect consumer appeal. Very largely this class of business has been developed by a large group of small manufacturers and in addition by a few large manufacturers that have a small production of each product in a single large division of their company activities.

The market area type of appliance manufacturing plant is growing. There is no standard of quality for appliances. There is keen price competition. There is a very complex and cumbersome distribution system. And there is very little growth in sales relative to the market saturation or to the rate of growth of the market itself. Thus, manufacturing in this class of business is handicapped very largely by reason of the distribution and sales organizations that intervene between the manufacturer and the consumer market.

In 1931, for example, the classes of retail outlet and the per cent of total sales for electrical appliances exclusive of radio and lighting fixtures was approximately as follows: Specialty dealers, 36; central stations, 22; department stores, 15; hardware and merchandising stores, 9; contractor-dealers, 10, and miscellaneous outlets such as drug stores, chain stores, mail order houses, etc., 8. This complexity in the ultimate retail outlets is reflected back through the jobber and manufacturer and is modified by the treatment accorded each of some hundred different electrical appliances sold in this con-

sumer market. Yet the householders of the country paid some $2,000,000,000 for electrical appliances and wiring in 1929 despite the cumbersome and expensive distribution and sales systems.

This is the time to give vigorous and constructive attention to improving the competitive condition of the electrical industry in the consumer market. It is large; its development has a decided bearing on social as well as economic welfare, and sales to this market will quickly reflect themselves in increased sales of other electrical apparatus needed to serve the consumer demands for energy.

All elements of the electrical industry—manufacturers jobbers, dealers and utilities—are interested in the common objective. Surely the opportunity is large enough for all elements to get together for formulating policies and practices that will expedite sales and make purchases more economical for the buyers and more profitable for the sellers.

Problems that need solution

Some of the major problems now confronting the industry in its approach to the domestic market are:

1. Anti-merchandising legislation, both state and national, confronts utilities, forcing them to consider several modifications in present merchandising practices. Some have withdrawn from merchandising and devote their efforts to building up other retail outlets and the creation of consumer demand. Others have continued to sell only heavy-duty pioneering appliances such as ranges and water heaters. Still others have continued to merchandise, but with a greatly diminished sales pressure, because of co-operative effort to develop other retail outlets. Undoubtedly the result of this trend has been a decrease in sales aggressiveness and sales volume.

It is a sound principle of merchandising to develop numerous and efficient retail outlets whether utility, department store or dealer and the crux of this situation is co-operation as well as competition in merchandising whereby practices are developed that enable all outlets to do a profitable business and yet all cooperate in the creation of consumer demand.

2. Time-payment selling is popular but difficulties are encountered in carrying out the principle. It has been suggested that utilities finance time-payments for all outlets and some do. It has been suggested that national time-payment investment organizations finance time payments, but the cost is great and the credit standing of the different outlets is so different that apparent discrimination results. It has been suggested that appliance manufacturers finance time payments and some do on some products.

A recent and very promising suggestion is to form in each market area a time-payment finance corporation that will be underwritten by manufacturers, utilities, jobbers and retail outlets. Credit and collection would be handled by the participating agencies, all of whom would have a financial responsibility in the results. This approach is promising, but it is a new and untried realm for most of the participants and undoubtedly will not develop very rapidly.

3. The quality of appliances, for a long time, has created quite a problem, many appliances of inferior quality having been put on the market, causing dissatisfaction in the home and preventing in many cases future sales. It will always be difficult to evaluate quality due to the fact that different quality and different priced appliances must be bought and sold if all the buying strata of the consumer market are to be reached. However, this is a problem that should have the fair and co-ordinated study of all interests in the industry to see what may be done to clarify the situation.

4. Discounts to different retail outlets and terms of payment also enter the situation. Two aspects justify discounts, one is volume of purchase and the other is the discount involved in going from manufacturer, wholesaler and retailer to consumer. It is questionable whether appliances are sold in sufficient volume to any retailer to justify differential discounts for quantity purchases. It is apparent that serious industry study should be given to this aspect of the business.

5. Multiple selling instead of single-product selling offers possibilities in economical and rapid consumer market selling. If it is possible to sell an electrified home or room at one sale undoubtedly economies in distribution may be obtained. Many plans have been proposed and some have been tried to sell appliances on this basis, but relative to the sales made by selling individual appliances the progress has been slow. To take full advantage of this idea some complete and radical changes are necessary in the distribution mechanism. It is a goal to work toward for it offers most attractive possibilities.

To these factors must be added the need for statistics, the control of local codes and ordinances, the necessity for getting adequate wiring, the problem of handling maintenance, repair and reverts and co-operation in the creation of consumer demand.

Thus, there is an enormous complexity associated with sales to the consumer market. No generalization is safe to apply. The logical approach is for industry agreement on national policies and principles, the development of sound practices by the manufacturer, wholesaler and retailer and the application of principles and practices in each market area so modified as to be workable at once and so operated that ultimate goals will be reached without friction.

Fifty years after the light and power industry started there still remain many problems. Current problems deal in many ways with the market development instead of engineering construction.

Since October, 1929, there has been a great recession in the electrical manufacturing industry of the United States. For the last two or three months it has seemed that at least the bottom has been reached and now is the time for real constructive work to bring back the industry. With the courage and vision that characterized the pioneers of fifty years ago, industry can go forward. Electrical manufacturers must and should play a star part in the future developments.

Since the inception of the electrical industry the social, economical and political life of the country has been changed. Without the electrical industry there could not have been, by any means, the progress that has been made in the world in the last fifty years. Therefore, the electrical industry should be the one to bring the country back to prosperity. With co-ordinated effort it can do as much as, if not more than, any other group to bring this about.

***November 1, 1884*—The Westinghouse Engine. Although the Westinghouse engine has only been before the public for about three years, the sales have reached such a point that it is necessary to provide for a manufacturing capacity of 100 engines, approximately 3,500 hp. per month, or four engines nearly every working day. In view of this unexampled development, the Westinghouse Company has determined to adopt a new business policy. The company as such will no longer solicit sales direct from the customer. The capital and energy heretofore expended in this direction can now be called in and concentrated strictly upon the manufacture. The selling department will be transferred to a few parties with high responsibility, operating in defined territories under close contract of a nature to reciprocally guarantee the perfection of the engine and the placing of the total product for cash. The effect of this arrangement is to practically double the working capacity, enabling the company to secure a larger stock of engines for immediate shipment, reducing the cost and giving the purchaser the advantage of council with an expert salesman in place of a mechanically experienced commission agent.—"Electrical World."**

Science Holds Key to Unlimited Electrical Era

Output saturation deferred by new air-conditioning and space-heating developments.

Electronics have not even scratched power possibilities.

Improved magnetic and dielectric properties will cut losses, weights and costs of electrical equipments.

Crop stimulation by electrical means—a hopeful source of load.

Beneficial physiological uses of electrical radiations a future boon.

ADVANCE of electrical technique seems to be punctuated by half-century periods. Two of them are matters of the past and we are entering the third. In what way can the significant strides of those past ten decades be viewed as semi-quantitative ordinates on a rising curve that augurs accomplishment for the impending era?

It was fifty years from the electromagnetic discoveries of Faraday and Henry to the first successful and sizable application of those principles to commercial exploitation of the phenomena, the opening of Pearl Street station to service for lower Manhattan. The succeeding fifty years witnessed the evolution of an industry of international proportions that has transformed civilized living and thinking in many departments, biological, social, economic, legal. Inasmuch as these qualitative transformations and benefits have followed the unfolding of the technical advances, much of their future significance will in turn hinge upon the marvels which the research laboratories can be expected to release for practical adaptation in the early future. A glimpse behind these fountains of potential knowledge provides a romantic prospect which, however, is best and safest portrayed in unemotional language. Just as a.c. generation in 1886, a.c. transmission in 1891, Niagara in 1894, the steam turbine in 1900 and electronics in the last decade are milestones, so there are similar milestones discernible in the vista ahead.

Two distinct areas can well be set up for the preview, the capacity for enhanced development of the power generating and transmitting system and the capacity for increased industrial, commercial and household absorption of its output. The great advance in the electrical end of power generation has been substantially greater than the improvement in prime movers and methods of extracting energy from fuel. This relative difference in rate of development can probably be accounted for by inherent limitations imposed by the laws of thermodynamics and the limitations in available materials for use at high temperatures. Besides, the steam engine had already gone through years of development before its initial use as a prime mover in electrical generation.

For years each advance in size of systems, generating and transforming units has brought hints of ultimate limits which, however, have repeatedly been surpassed. As in the past, developments of better materials, higher speeds, new methods of construction and new kinds of equipment will undoubtedly shatter our present ideas of ultimates and allow continued and accelerated growth.

On the horizon of a few years ago we saw the bright future of super-power, extensions of vast interconnected systems. This vision was then dimmed by problems of system stability, lightning protection, switchgear limitations, etc. By scientific and engineering development, field research on the characteristics of and the effects of lightning and laboratory research and development on lightning protective apparatus and the fundamentals of arc-rupturing phenomena have removed obstacles in the way of super-power development and brought us face to face with new questions of economies in interconnection, growth and type of power systems and the placing of generating units in these systems. It seems as though future expansion will be governed mostly by the cost of generating and distributing power and by the magnitude of power demand. Apparently the tendency will be toward increased capacity at load centers.

It seems safe to predict that power consumption based on present applications will be greatly stimulated through economies in power production and distribution which will result from new developments in construction and entirely new types of equipment and systems for the generation, conversion, transformation, control of electrical energy.

In the evolution of electrical machines we have been repeatedly handicapped by the unsatisfactory properties of available materials. Magnetic materials with lower and lower losses and better permeability have successively been brought forth by painstaking metallurgical and magnetic research. These developments and applications are not at an end and recent discoveries and laboratory results indicate the possibility of reducing iron losses to but a small fraction of the present figure. The theoretical studies of molecular structure indicate the possibilities of making substantial increases in the permeability of magnetic materials, which will in turn give us smaller and cheaper electromagnetic equipment.

The progress in insulating materials and the improvement of conductors have in general been less than improvements in iron. Our increased theoretical knowledge of dielectrics and new considerations of metallic conduction under the theory of quantum mechanics gives some hope of improvement in these materials within the years to come.

Metallurgical investigations have pointed the way to much better alloys for the designing engineer to allow higher speeds, greater strength, strength at high temperature and greater resistance to erosion. Steam turbines have been limited in efficiency due to material limitations to moderate temperatures and centrifugal forces. These limitations should surely be removed to enable the thermodynamic range, speed and resistance to erosion to be increased sufficiently to improve our prime mover efficiency.

Development of materials, together with many other

improvements in Diesel engine design, may also greatly affect the prime mover situation in the electrical industry and call for radical changes in the nature and layout of our rapidly growing power systems.

It is interesting to follow and speculate on the possibilities of the gas turbine and power from the winds, tides and solar radiation. The gas turbine is a most promising possibility. The harnessing of the winds and tides seems uneconomical at present as the investment cost and variability of winds will for some time keep them from being competitive with the steam plant. All of the useful energy on the earth has come from the sun and has been stored for our use in periods ranging from zero to many million years. The solar radiation is intense and of the highest type for direct conversion into power.

Many projects for using solar energy by conversion through heat to electricity have been proposed and worked upon. The reduction to low-grade heat energy must be attended by serious losses in efficiency. The greatest hope, and in fact the promising hope, of using solar energy, which amounts to 124 watts per square foot, is to make the conversion of high-grade short-wave energy directly into electricity through the medium of photo-galvanic, photo-voltaic or other devices which are far from being practical as energy converters today, but which are being rapidly developed and may be of great importance in the next few decades. The principles involved in this work are those of quanta, wave mechanics, electronics, etc., into which the whole physical research world is now delving. Initial investment and continuity of output are again the questionable factors.

Recent predictions indicate a tendency toward saturation in power consumption in the near future. Our prophets certainly do not base their conclusions on the statistics which show a trend toward accelerated increase in electrical consumption up to the present time. They must have based the predicted approach to saturation on possible loads available for the *present* applications for electric power.

It might be permissible to discuss more fully some of the bright spots on the horizon, some of them imminent and some dimly outlined as speculative and hopeful. Probably the brightest load-building possibility at present is air conditioning. Air conditioning will give new connected loads for the heating and cooling of large buildings and homes. In addition there will be power-consuming devices for increasing humidity in winter, reducing moisture in summer, for cleaning and purifying ventilating air and for controlling the ionic content to meet the specifications for a healthy climate. With the assumption that air conditioning will eventually find wide application in the domestic field, it seems fair to predict that with electric house heating supplanting fuel heating there will be a load which will put domestic power at the top of the list and make the air-conditioning demand the greatest of any general classification.

Another bright spot on the horizon is the extensive application of electronic devices. The results from the laboratories and early application show that we have a right to expect metal vapor and vacuum devices to revolutionize and simplify the production, distribution control and utilization of electrical energy. Great improvements can be expected in mercury-vapor rectifying-converting and frequency-changing devices, which will greatly extend the use of electricity by enabling it to be used with greater safety, flexibility and efficiency. Recent experiments and scientific research indicate that vapor arc devices fed from a.c. systems can be used to get the great flexibility and general utility of direct current without adding complication to the a.c. systems or requiring the maintenance of d.c. districts.

A great deal has been said about the many applications of vacuum devices, grid control tubes, photo-electric tubes and other electronic devices which are becoming so valuable in control, industrial metering, interlocking and safety devices. Each day we hear of new possible uses for these tubes and electric eyes and it seems fair to predict that in the periods just ahead they will tend to extend the use of electricity to the many new fields by controlling with safety and rendering industrial processes automatic and safe. Those close to developments often make the statement that tubes can be used to do practically anything electrically and automatically. There are so many possibilities that their almost universal application can be looked for in the years to come and in a way that will stimulate the use of electricity.

The photo-electric tube is much more rapid than the eye, is untiring and is sensitive to differences in light intensity and in color not only in the visible spectrum but in radiations which the eye cannot perceive. It has been reasonably said that any act to be performed in response to a simple sensory stimulus can probably be better performed by an electron tube than by a human operator, and that just as in the past electric motors have taken over most of man's muscular drudgery, so in the near future electron tubes will take over most of the routine drudgery in such operations as inspection, counting and sorting of materials and devices and of supervising and controlling automatic machines, furnaces and the like.

But there are limitations to the use of electron tubes for such purposes. A photo-tube can count the cars passing through a tunnel and do it more cheaply, accurately and tirelessly than a human operator, but it is not so well adapted to distinguish between the different makes, and still less to appraise the relative values of individual cars, as is the human eye. But these latter operations involve synthesis of observations of several features and deduction from that synthesis; in short,

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***October 18, 1884*—A Five-Year Campaign.** "The great secret of doing away with the intermediary furnaces, boilers, steam engines and dynamos will be found, probably," says Mr. Edison, "within ten years. I have been working away at it for some months and have got to the point where an apparently insurmountable obstacle confronts me. Working at the problem now seems to me very much like driving a ship straight for the face of a precipice and when you come to grief picking yourself up and trying it again tomorrow. There is an opening in the barrier somewhere and some lucky man will find it. I've got far enough to know the thing is possible. I can get quite a current now directly from the combustion of fuel. Jablochkoff tried his hand at the same thing some years ago, as did some Germans, but the results were laboratory curiosities only. I give myself five years to work at it and shall think myself lucky if I succeed in that time. The unscientific world has no conception of what the discovery would mean. It would put an end to boilers, steam engines; it would make power about one-tenth as cheap as it is now; it would enable the steamship to cross the Atlantic at a nominal cost; it would enable every poor man to run his own carriage; it would revolutionize the industrial world.—"Electrical World."

***March 15, 1884*—A Modest Scheme. A Rochester experimentalist solicits $20,000,000 or more to carry out a gigantic electric lighting scheme. His plan is to use the power of the great Horseshoe Falls at Niagara for working ten engines of 200,000 hp. each. These, he thinks, will generate enough electricity to furnish light to the 65 American and Canadian cities with which they will be connected by an extensive system of underground wires.**

***June 28, 1884*—The Feasibility of Utilizing Niagara. The power of Niagara can be estimated very approximately. The average flow of the river, according to the many careful measurements, is 275,000 cubic feet per second. The fall in the river through the rapids immediately above the fall is 65 feet. The height of the falls is 165 feet, making a total of 230 feet; thus we have for the whole power 7,000,000 hp. To utilize this amount of power by waterwheels, generate electrical current, and transmit to various cities within 500 miles, it would necessitate a plant representing at least $5,000,000,000. Such figures as these give some idea of the enormous amount of power here in reserve. A small proportion of the power of Niagara is already utilized and a much larger amount can be developed at moderate cost.—"Electrical World."**

mental operations. It has been said that the extent to which, in any society, human toil has been shifted from hand to brain is a measure of the height of its civilization. The electron tube, like the electric motor, is relieving the hands of men, but leaves to their minds the thinking, and gives them more time for thought.

Possible new ways for taking small quantities of electric power direct from existing power transmission lines are to be found. To some it seems a crime that we cannot give individual farms the cheap power which everywhere crosses the land. But safety devices, circuit-breakers, insulators, switches and transformers still cost too much. We may cheaply tap a water pipe for any delivery, we can tap a gas line for any desired rate of flow. But the power line merely decorates the farm, while farmers still saw wood and pump water by hand.

The use of power has immense possibilities on the farm, for so little seems to be known about soil temperature, fertilizers and plant growth. When some roots run several feet for food and drink, how much could they be helped by insuring contact with a nearer supply of moisture and fertilizer? In other words, how much of the soil do they actually need? The ash of the plant shows how little soil is really used up.

As for the home, it seems sure that electrical kitchens will be sold complete, because the need for co-ordination, economy of space and capital are now recognized. The next step, already being taken, calls for the completely fabricated house, including refrigerator, heater and air conditioner. These facts insure opportunities to improve countless details—plenty of work to do.

In the field of lighting, refractory elements and alloys for lamp filaments have been investigated and refined to a point where not much improvement in efficiency can be expected from the present type of incandescent lamp. But revolutionary changes in lighting are said to be ready for wide application. New lamps will be of the vapor-arc and glow type and will have efficiencies far beyond those of the present type. Better efficiencies mean less power for the same light, but better efficiencies have always gone hand in hand with increased power because of wider application. Vapor lights of proper specular distribution will also be used extensively for the creation of healthful ultraviolet radiation, for treatments, sterilization and various purposes in the chemical and other industries.

The whole field of electric radiations and their effect on living tissue and on man is practically new. Radiations are being used more and more in therapy—X-rays in cancer, ultra-violet in rickets and skin disease, infrared in rheumatism, high-frequency electric waves in diathermy and radiothermy for divers diseases, but this work is hardly begun. And when all diseases are conquered, who knows how much the bodily and mental well-being of the race may be raised by proper radiations properly applied? The very mental ability of man himself depends on controllable reactions apparently operating through electrical, physical and chemical processes to whose understanding and better control there need be no bar.

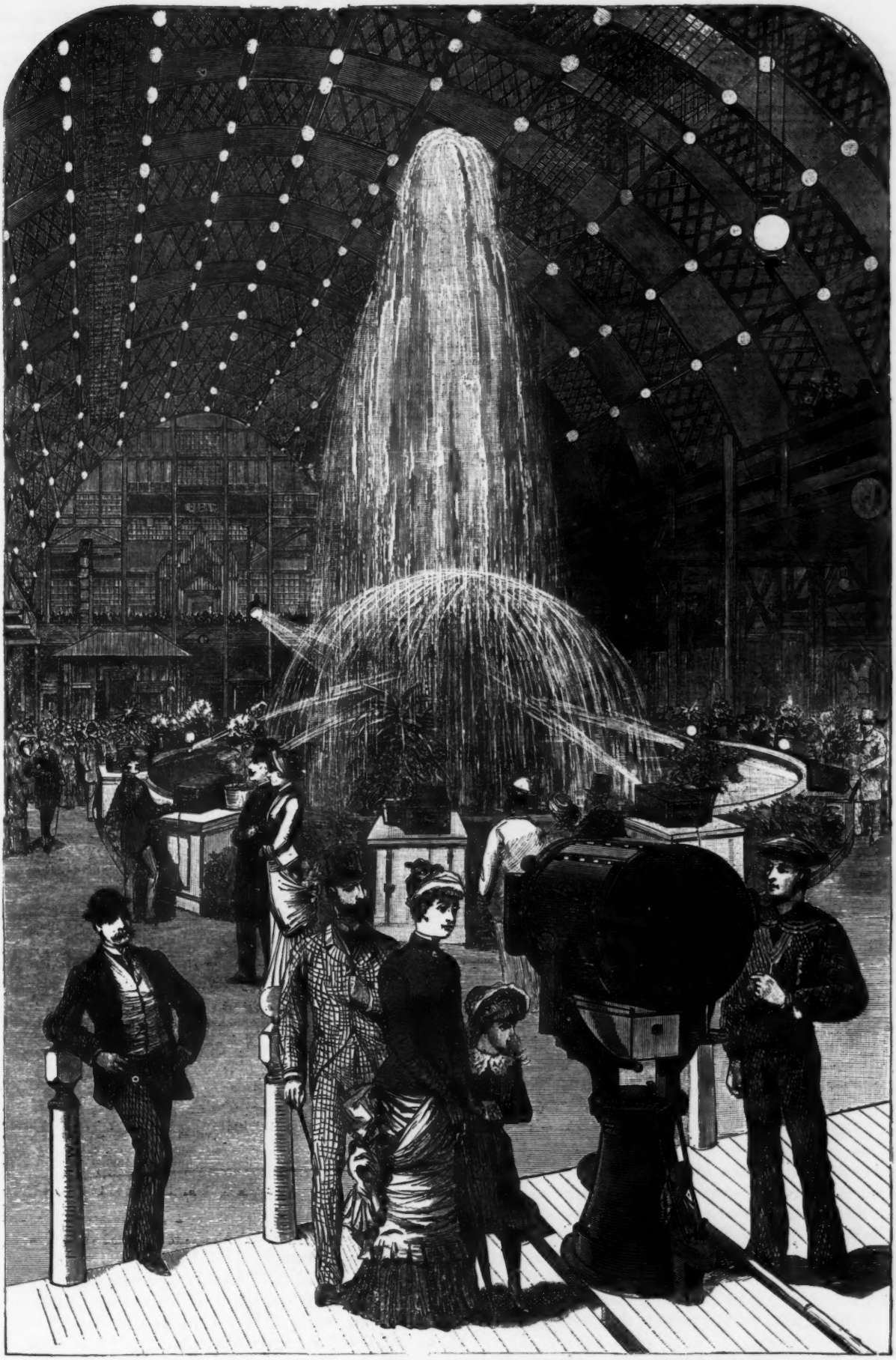
Experiments at Harvard and elsewhere indicate that the degree and kind of ionization of the air have their effect on comfort and health. The air conditioner may include in time an ionizer and ionstat.

Electrically the senses are being separately refined. Sounds we cannot naturally hear are electrically amplified. Dimensions we cannot normally distinguish are electrically magnified, so that machine work may be more accurate than formerly. A small attack has already been made in increasing the sense of smell. Carbon dioxide and monoxide can now be detected electrically and quantities of smoke or fog too dilute to be perceptible ordinarily are easily distinguished. Such things set engineers to further study of existing senses and their improvement, as well as of possible senses not classed as natural.

Much of man's inventive genius has been devoted to extension of his senses and his faculties for work and ideation. In the past his vision has been extended by the telescope and most recently by television. Speech and hearing have been enhanced by telegraph, telephone and radio. Muscular effort by myriads of mechanical and electrical devices; locomotion by air, land and water agencies. The new era presages an attack on the vaguer senses of perception and the faculties for control of health, comfort and evolution. These in themselves may represent small loads, electrically speaking, but nevertheless they carry a potentiality for correlated large-scale uses that give the lie to saturation.

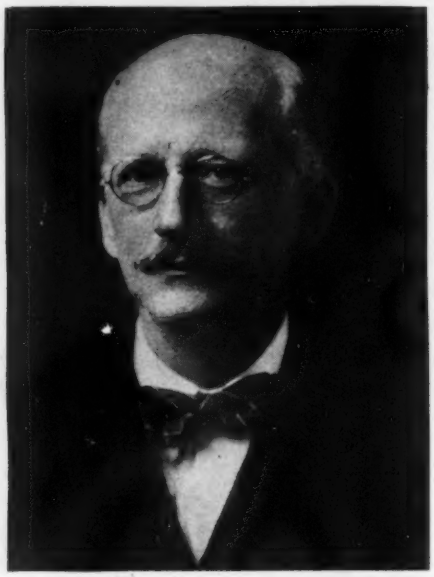
There will probably be more electrical discoveries made in the next few years than have been made in any other equal time. There are more scientists and young electrical engineers now than ever before. Until recently these men were pretty actively engaged in work which was directed by pressing industrial needs. Now more of them are freer to contemplate, to wonder, to experiment and to plan new work than ever before. So it would not be surprising if some of our most radical changes were brought about in the next few years. This is cyclic, because, as new ideas are developed, more and more engineers are thereby required.

Invention, engineering development and application of electricity in new fields are not at an end. There are today literally thousands engaged in organized and scientific developments. The vast number of new discoveries and promising developments in laboratories and the great improvements in sight based on scientific developments make it appear that new and extensive applications of electricity will remove any tendencies toward saturation years into the future.



AT THE INTERNATIONAL ELECTRICAL EXHIBITION, PHILADELPHIA, 1884

Electric Power for All



Anticipates more than 2,000 kw.-hr. per year average from farm and city domestic customers.

Industries still to be motorized; new ones to be developed.

Medium-size generators most widely adaptable.

Binary-vapor and Diesel units may extend maximum economy to smaller units.

Pondage and water storage pay well.

By GEO. A. ORROK
Consulting Engineer, New York

THE use of power in this country has grown to such enormous proportions that we may well wonder how our forefathers got along with the very small amounts of mechanical power at their disposal. Since the opening of the Edison Pearl Street station progress has been increasingly accelerated until the best estimates we have been able to make show a use in the United States as of January 1, 1930, of 1,193,000,000 hp. of prime movers for all purposes, an increase of 65 to 1 in the intervening fifty years.

Long-range vision was demonstrated by Dr. Thurston back in 1880 when he recognied that Edison's improved dynamo, giving over 90 per cent efficiency, would make possible the transmission and distribution of electric power over long distances in any desired quantity and prophesied that electricity would become more and more useful in the production of power as distinguished from electric light. However, Mr. Edison also foresaw this possibility two years before, as shown by entries in his 1878 notebook, where he says: "It does not matter if electricity is used for light or power; generally the poorest district for light, the best for power, thus evening up the city."

Statistics on the growth of the power industry in the last fifty years are to be found in many places and show by far the largest increases in the use of power-producing machinery in the transportation industry, which accounts for nearly two-thirds of the primary horsepower used in the United States.

Energy outputs have doubled, on an average, about once in a little over three years, until the kilowatt-hours generated today amount to around 90,000,000,000. The amount sold to ultimate consumers is roughly something over 75,000,000,000 kw.-hr., while the installation of all forms of prime movers in the central station industry amounts to over 30,000,000 kw., supplying about 25,000,000 customers, or an average use per customer of more than 3,000 kw.-hr. per year. It is extremely difficult to separate the amount of energy used for lighting from the total, but the power use is apparently at least 65 per cent of the total. The average domestic customer uses about 560 kw.-hr. per year, while the power customers' use is probably in excess of 15,000 kw.-hr. per customer.

Of our 120,000,000 population, about 67 per cent, or about 84,000,000, live in houses or apartments wired for electric service. All of these customers use electric auxiliaries to customer comfort to a very large extent and new appliances are being purchased at the rate of about 5,000,000 appliances per year. The accompanying table (page 473) shows the distribution of the various kinds of apparatus.

It is estimated that the electrical helps in the household use more than half of the domestic consumption of electricity. And the saturation point is still far ahead! We may look forward to another 10,000,000 domestic and farm customers with an average use for the year above 2,000 kw.-hr. In 1920 it was estimated that industry was about half motorized and new motors and the use of electric power were increasing rapidly. At the present time industry is about 80 per cent motorized and the use of electric motors is increasing at about the regular rate. Estimates vary from about 60,000,000 hp. to 80,000,000 hp. of electric motors in use in industry, but it is my opinion that a total of more than 110,000,000 hp. of motors is in use in this country at the present time. The 1929 census reports 50,000,000 hp. of motors used in mines and industry at that date and this figure does not include the 17,000,000 hp. of motors sold to industry during 1929, 1930 and 1931, nor the 6,000,000 hp. of small motors sold in the same years. Outside of these figures are the fan and elevator motors in our tall buildings and the motors on shipboard and in use by farmers, stores and public buildings.

It would appear that 110,000,000 hp. is a conservative figure and shows the widespread distribution of the use of power in the household, the farm and industry.

There are still many industries to motorize and many new industries to be developed which will use power. The 5,000,000 power customers may not greatly increase, but the 15,000 kw.-hr. use per year by these customers will very surely be largely increased. I look toward increasing the average use per customer (lumping all classes) from 3,000 kw.-hr. to about 6,000 kw.-hr. without reaching saturation.

Meanwhile, we have seen our generating units grow in size from the 100-kw. unit of Pearl Street station to the 160,000-kw. units of Hell Gate and Hudson Avenue and the 205,000-kw., three-shaft unit at State Line. With the differing degrees of concentrations of load that exist today such large units are applicable to only a few sys-

tems. Opinions differ as to the growth of concentration of population, but the consensus of opinion is that both population and industry will become more widespread. It would appear that these generator ratings are sufficient for some time to come. For the country as a whole more medium-size units—50,000 kw. to 100,000 kw.—would be indicated.

Steam plants in both large and small sizes can be built to give good efficiency, but the maximum commercial economy, taking into account both fixed and operating charges, cannot be reached at present with units under the medium rating. However, binary-vapor plants (the mercury turbine) have great possibilities and may allow slightly smaller units—20,000 kw. to 40,000 kw.—to enter the maximum economy picture if the first cost is low enough. The latest units of the mercury-vapor type have a capacity of 20,000 kw. for the mercury turbine and, besides, furnish 300,000 lb. of steam per hour, equivalent to 35,000 kw. or 55,000 kw. for the unit or about the lower economic limit for the medium-size plants.

Diesel plants under favored conditions—cheap oil, costly water and cheap first cost—may again lower the rating for best commercial economy, but it does not appear that this has been accomplished in any existing plant in this country.

Combinations of steam and water-power plants with sufficient pondage and storage have been the most successful combination, while run-of-river plants in combination with steam have not been nearly so satisfactory. Pondage and water storage pay well.

The question of purchased service versus the private plant for commercial light and power customers, which has been a moot question in the past, is apparently no closer to solution today.

Because of the great economies which have been made in the cost of generation, distribution costs constitute a much more important factor in the central-station business. Commercial customers have always balanced the convenience of central-station service against the supposed savings due to the elimination of the distribution and service costs.

In the absence of a steam-supply company to take care of the winter heating the use of central-station service does not do away with the heating plant. Where district steam supply is available the costs of distribution are always an important factor.

There have been many attempts to use a Diesel-engine installation or to put in small Diesel plants, largely automatic in character, particularly since oil prices have been at the low level. But the first cost of such installations has usually been above or close to the border line of commercial economy. In European countries, however, the cost of a Diesel plant has been brought down to such a figure that it competes freely with the central-station service abroad. The central-station industry there has taken advantage of the comparatively cheap prices of Diesel machinery to install peak-load and substation units of the Diesel type to carry peaks, relying on the larger steam or hydro apparatus to carry the main load on the central-station system.

In this country, as elsewhere, the question is one of commercial economy and it appears doubtful if Diesel competition with central-station service can be any more successful than Diesel generation would be in a central-station system.

Where the heating season is long and the winters are cold, as in the Northern states and Canada, steam units of the back-pressure variety with auxiliary Diesel generation for summer use have been installed. But in most of these cases the commercial economy is on the border line and is still in dispute.

It should be obvious that any private plant, to give the same quality of service as a utility system, must carry sufficient reserves, which in turn increase the fixed charges materially.

From the standpoint of the public health it appears essential that both central-station electric and steam service should be used to the largest possible extent to restrict the combustion of fuel to plants of sufficient size to warrant the installation of the best types of furnaces and the proper dust and smoke elimination devices. Removal from the streets of the transportation of fuel and ashes for the many individual plants would undoubtedly aid the transportation problem, which in all our large cities is most difficult and pressing.

Industrial plants which use process steam, possibly including hotels and laundries, are in a rather different category. When the use of process steam and hot water is large it is a simple matter to generate all of the power required for the plant by a reasonable increase of the steam pressure, the prime mover exhausting at the required back pressures for the process work. But

Electric Appliances in Use in Homes

Flatirons	19,685,000	
Vacuum cleaners	9,165,000	
Radio sets (a.c. only)	11,000,000	
Toasters	8,195,000	
Fans	6,250,000	
Percolators	6,025,000	
Space heaters	3,370,000	
Electric clocks	3,650,000	
Total		67,340,000
Ranges	1,057,500	
Water heaters	238,500	
Washing machines	7,580,000	
Ironing machines	700,000	
Oil burners	554,000	
Refrigerators	3,022,500	
Total		13,152,500
Grand total		80,492,500

***January 12, 1884*—Mr. Thomas A. Edison, the electrician, was found last week by a city reporter at his office, 65 Fifth Avenue, engaged in studying out plans for the erection of two monstrous stations for the Edison Electric Light Company, one to light the field from 24th to 44th Streets and from Eighth to Madison Avenue, and the other from 44th to 59th Streets and from Eighth to Madison Avenue. The former is to have a capacity of 7,000 hp. and the latter 9,000.**

"They will be 'busters,'" said Mr. Edison with a smile. "The growth of our business demands this great enlargement of our capacity. In this district $1,500,000 are yearly paid for lights. We must have that money, you know, and no gas or any other sort of company can prevent us."

Mr. Edison also stated to the reporter that at a charge of 1¼ cents per hour for each burner his light was gaining popularity everywhere to the extinction of gas, and that in the next two years he and his associates will probably furnish light to 200 towns and cities in this country.

—"Electrical World"

many hotels find it economical to purchase both steam and electric service from the utility system.

Many large industrial establishments are making their own power and heat, but the cost of their power is a matter of bookkeeping, depending on whether or not the power may be considered as a by-product. The paper, sugar and other similar industries contain many examples of more or less successful efforts to balance power and heat supply. Where the amounts of power are larger than the process requirements, condensing prime movers are frequently used and competition with the utility service appears.

In plants which have considerable waste heat from which power may be made quite easily arrangements have been made between the local utility and private plant for interchange of energy, with profit to both the industrial plant and the central-station company. In the case of the Union Générale Belge d'Electricité all of the industries in the district—metallurgical, chemical and manufacturing—have been tied in with the central-station plants, securing for all the advantage of the better and more economical plants and reducing the amount of capital necessarily invested for power purposes. Proposals of the same kind have been made in this country, but there has been no concerted action to study a large group, similar to what has been done in Belgium.

In most cases in the United States the continuity of operation, so desirable in any arrangement of this sort, cannot be guaranteed over a period of time and the type and quality of the service which would be rendered might constitute a menace rather than a help to the high-grade utility service. It is also a fact, in most of these cases, that the diversity which might exist and which is a necessity for the successful operation of arrangements of this type did not exist or could not be arranged. These facts, coupled with the operating difficulties caused by many small connections, have constituted the major reasons why interchange arrangements have not been more generally concluded.

It is a comparatively simple matter to throw 100,000 kw. on a central station, but it is decidedly troublesome to collect the same amount of power from 100 to 250 small plants scattered over the system.

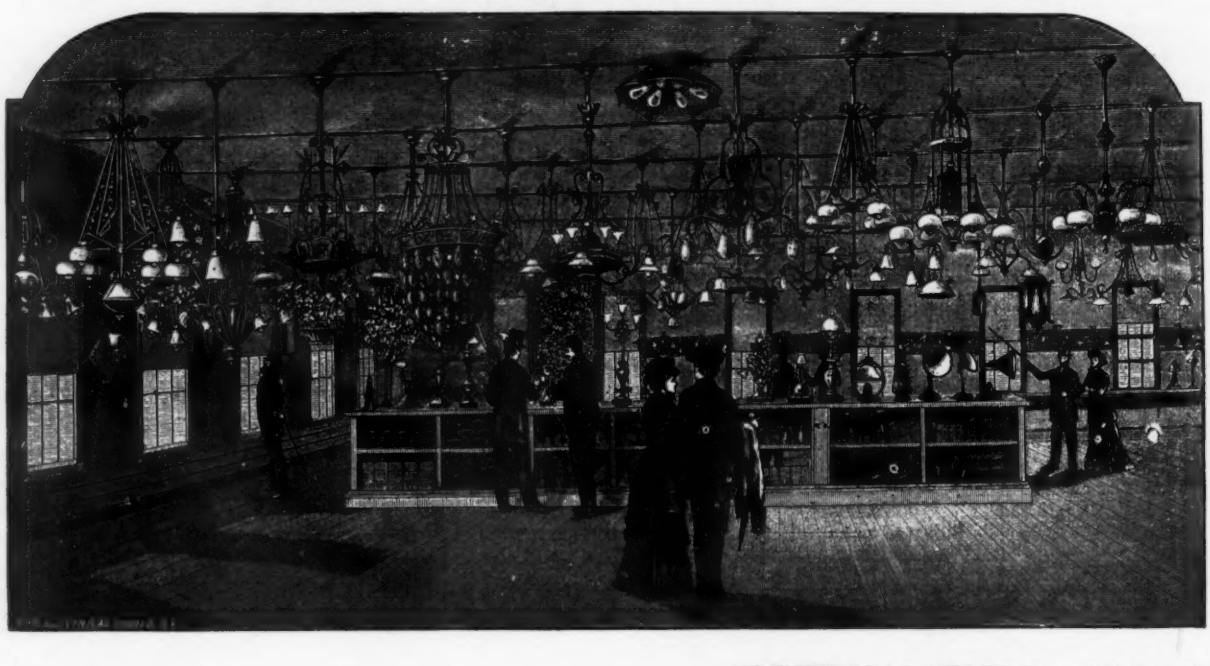
Where interchange arrangements have been shown to be commercially possible they have been used, and the future may see many more of this type of connections used to the advantage of both the industrial establishment and the utility company. It is important, however, that the quality of the industrial installation and its operating personnel should have the same high standard demanded in utility service.

The first twenty years of the central-station industry may be called the pioneering or introductory age, for it was then that the industry was engaged in extending its services to all parts of the country. Local companies served the communities, farm customers were non-existent and the power customers were small and of very little importance. Load concentrations were low and transmission had been used in only a few cases. The electric railway was generally local and interurban services had hardly been tried out.

It was toward the end of this period that the industry discovered diversity and took advantage of this factor in both generating and distribution systems. The fact that the peak load occurred at 4:30 p.m. downtown and at 6:30 to 8 p.m. outside the business district brought into existence transmissions connecting the two types of load areas, increasing the load factor and taking advantage of the diversity. This principle became generally recognized in 1898. A little later the diversity between light, power and street railway load was taken into account and a further increase in the load factor up to 50 per cent perhaps was made possible.

The existence of diversity was proclaimed "a wonderful discovery" and in the opening years of the twentieth century "interconnections" were started. For another twenty years most of the systems were interconnected, with very little attention being paid to possible diversity and with the stress laid on water power and economical steam stations. During the last ten years "planned" systems have come into being—the English "grid," the Italian high-tension lines, the French and German state-

SELECTING ARTISTIC LIGHTING FIXTURES IN 1882-84



aided networks, the Union Générale Belge d'Electricité and our own "holding company" systems. The projected Soviet Five-Year Plan and the German-European union or network which may use 400,000-volt transmission, presented by Oliven at the 1930 World Power Congress, are other plans.

In the United States the Pacific slope, Nevada, Idaho and Montana are tied together and could be operated as a unit. In the East most of the country from New England through Niagara to Chicago and south to Alabama and Pensacola, Fla., have been synchronized and run as one system for a few minutes, using two changes

Distribution costs more important than formerly.
Combined steam and electric service—an answer to private plant competition.
Power interchange with industrials—some handicaps and future.
Three types of diversity bring benefits.
World-wide trend toward "planned" systems.
What is reasonable size of a regional system?

of frequency and small-size ties. But in all of these cases comparatively very little power has been transmitted over long distances. On the Atlantic coast the water powers of the Susquehanna have been tied in intimately with the steam stations in Baltimore, Philadelphia, New Jersey and eastern Pennsylvania by 220,000-volt transmission lines which transmit power in quantity. Here the separate diversities of load, waterpower and steam-plant operation combine into a large diversity. The New England Power and Niagara-Hudson systems are good examples of the application of the same methods under quite favorable conditions.

The Union Générale Belge d'Electricité is a unique example where practically every source of power supply—steam, hydro, gas and industrial plants—inside 5,000 square miles of territory with about 3,000,000 population, is connected into one system and run as a unit for the benefit of all power sources and customers. Owners, customers and the government are all represented on the board of directors. The installation involves about 500,000 kw. generating capacity with an output of 1,700,000,000 kw.-hr. per annum. By shutting down uneconomical plants and thereby producing better load factor on the more economical plants the earned savings have been substantial.

In Italy the diversity between the hydro plants fed by the melted Alpine snows in spring and summer and those further south which draw their water from the winter rains on the Appenines has been utilized by tying the two types of hydro plants together by high-tension lines to which the steam stations are also connected.

In France the steam-generated systems of the north have been connected with the hydro-electric supplies of the "Massif Central," the Alps and Pyrenees.

Switzerland is about 90 per cent electrified with ties to Austria, Germany, France and Italy.

Germany has had a plan of connecting her eight or ten regional systems by high-tension links, utilizing her rather limited water powers and the enormous brown coal areas to supplement coal-burning industrial areas.

Sweden is 85 per cent electrified with about 70 per cent hydro, which is widely interconnected with the steam-generating plants.

The English "grid" is still the subject of newspaper controversy, but any connecting system which will standardize voltages and frequencies and displace uneconomical, small and obsolete generating stations should earn large savings.

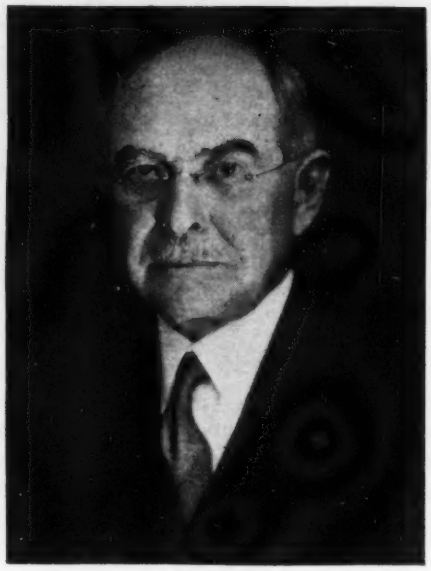
Load diversity was noticed at Pearl Street very early and made it possible to serve an installed load which is two to six times the actual peak demand. With the extension of the system and the building of additional generating stations time diversity was recognized and the early interconnections were placed in service, securing additional economies therefrom. Commercial diversity came into the picture with the great improvements in central-station apparatus and has become increasingly important as the larger and higher rated units have appeared with their lower first cost and operating expense. This commercial diversity arises from shifting loads from the older stations to the later and more economical installations. It even occurs in individual stations where the later and better units are used to carry a major portion of the output. The economies of this type of diversity are most interesting and may be examined in detail in the curves in the June 25, 1932, issue of the ELECTRICAL WORLD, page 1085.

It does not appear that any large amounts of power have been interchanged or transmitted over distances in excess of 250 miles. Indeed, the Hoover Dam-Los Angeles projected transmission of 500,000 to 600,000 kw. over nearly 250 miles of line will be the largest and longest power line contemplated up to date. The German studies up to 400,000 volts are tentative proposals and it is doubtful if a commercial analysis would show a sound financial basis for the proposal. In this country both financial and operating considerations have limited both the length of the lines and the actual powers transmitted.

The proper combination of local generation near load centers with tie lines or a network (the English "grid"), plus such additional long-distance lines as commercial considerations will permit, would indicate regional concentrations of electricity supply at once self-sufficient with emergency ties of relatively small capacity to contiguous regional systems. Considerations of the better service, the greater continuity and the minimum cost would apparently put a limit of reasonable size on these regional aggregations and discourage "shoestring" systems which transfer little power and consequently have a high unit-carrying charge on the transmission lines.

***July 19, 1884*—The Turin Electrical Exhibition. The International Electrical Exhibition held in connection with the Italian National Exhibition in Turin was opened on May 28. The electrical exhibition is not large, but its quality makes up for quantity. The secondary generator (transformer) of Messrs. Gaulard & Gibbs is exciting considerable interest among electricians as it is claimed to solve the problem of carrying a strong electrical current in thin wires to long distances whilst hitherto a thick and expensive cable was required for a current of equal power. Thus electric lighting is considerably simplified and cheapened by the introduction of this generator. (These developments involved the first transformer and a.c. lighting system.)—"Electrical World."**

Past, Present and Future



I believe that the next fifty years will be as full of problems to be solved, as full of adventure, as the fifty years just passed.

By E. W. RICE, JR.
Honorary Chairman of Board
General Electric Company

MORE than fifty years ago, when I was the youthful assistant of Prof. Elihu Thomson, pushing out under his leadership from a new frontier, I saw the electrical industry founded as merely a method of lighting with arc lamps. I have seen it extend and ramify in so many directions that I could not say today what the electrical industry is, much less attempt to define its ultimate limits. I believe that the next fifty years will be as full of problems to be solved, as full of adventure, as the fifty years just passed. We today are no less pioneers working out from the frontier than we were in the beginning—it is simply a broader frontier.

We know now that the great central-station industry of today, serving unceasingly, day and night, an entire nation, is a direct outgrowth of that modest little generating station first put in operation on September 4, 1882, at 257 Pearl Street, New York, by Thomas A. Edison. The arc light had already attained considerable practical usage in our country before this important event occurred. Indeed, for a few years the arc light remained the only article of utility to be supplied by the dynamo. Then, in the year just mentioned, it was joined by Edison's remarkably useful incandescent lamp. Both types of electrical illumination made use of the central-station idea, but, as events proved, future expansion through this plan of operation was based upon the incandescent lamp of Edison and not the arc lamp of Brush, Thomson and Wood. The small, unpretentious Pearl Street station, efficiently producing electric current for incandescent lighting and feeding that current into an electric supply system which distributed it to incandescent lamps in the surrounding area, became the parent of our present electric utility enterprise. That audacious venture was the acorn from which grew the oak.

The reason for this was logical enough. The incandescent lamp was an article of great popular convenience, small enough to be of service in the home and to illuminate moderate-sized rooms in dwellings as well as stores, offices, and similar places, in which the larger, more dazzling arc lamp was not acceptable.

If Edison had never done anything else than give us the incandescent lamp he would deserve our eternal gratitude. However, he did much more. He adapted to the needs of his system the parallel circuit idea, much improved by his ingenious three-wire plan. He insisted, and correctly, that no other method would adequately solve the problem of the generation, distribution and utilization of electrical energy, and upon this method of electric-current distribution, no less than upon the convenient incandescent lamp, was founded the beginnings of electrical supply systems in cities and towns on every side.

The sheer utility of the incandescent electric lamp facilitated the rapid establishment of generating stations and distribution systems identical in plan, operation and function with the historic Pearl Street station. The presence throughout the preceding three years of the arc lamp had prepared people's minds for further applications of electricity. They were made aware that this new physical agent could indeed be of service to mankind, and Edison's prestige as a seeming worker of miracles was sufficient to gain a hearing for any new scheme that came from his celebrated laboratory at Menlo Park. Hence, through the rest of that decade, Edison local lighting companies and Edison electric generating stations operated by those local companies to supply the Edison incandescent lamp steadily increased in number. Their success was invariable; their significance, although not well understood either by the technical fraternity or the laity, was immeasurable.

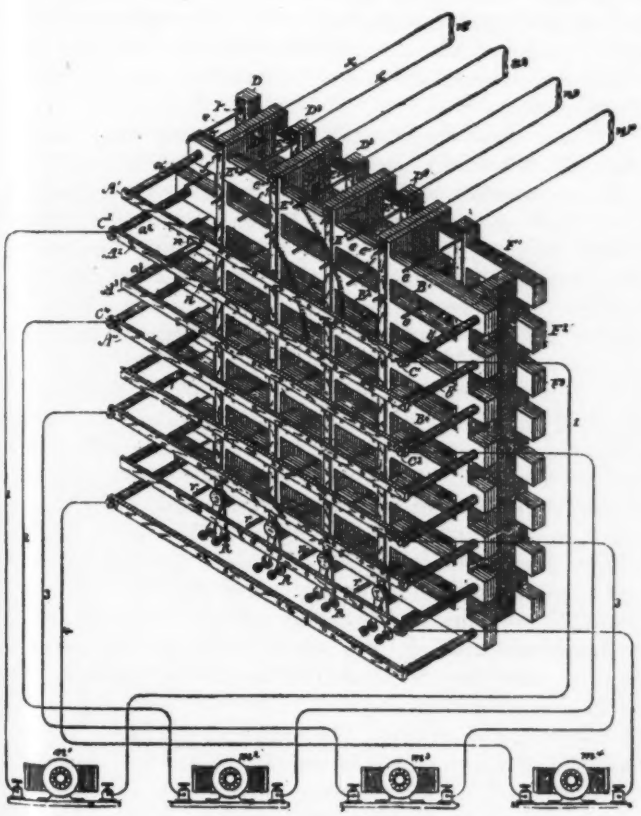
I well remember the great excitement caused by the original announcement by Mr. Edison of his discovery of what was then known as the "subdivision of the electric light." Professor Thomson visited Menlo Park soon after—about the spring of 1880—and brought back to Philadelphia one of these incandescent lamps. At that time we did not think highly of Edison's lamp. It seemed to us to give too small an amount of light ever to be very useful and it was inherently inefficient compared with the arc lamp. The incandescent lamp, for the time being, was just one more system. We did not see in it any great future. We would have been thrilled had we experienced a true vision of its destiny as the instigator of a new and far-flung industry.

Certainly, while we who were exploiting the arc light were busy enough with the problems and activities of growth, the incandescent lamp soon showed even greater vitality. After the two modes of illumination had been successfully demonstrated local lighting companies were

organized in different parts of the United States, backed by groups of men who had confidence in the success of such a venture. These groups approached the Edison company or the Thomson-Houston company for licenses under their respective patents. Licenses were ultimately granted to these local companies, but in most cases, because of a lack of funds, the royalties were payable in securities.

In some cases the manufacturer would be instrumental in the formation of the local lighting company, first securing a local franchise from a particular city and a contract for lighting the city streets, then interesting local capital and giving the local company a territorial license. In the early days of local lighting companies there was great lack of cash and great difficulty in raising funds necessary to make a start, and it frequently happened that in addition to the securities received for royalty the manufacturer had to invest his own funds in securities and take securities for apparatus sold.

The main thing, in the case of most of these local companies, was to get started, and once started it must be said that they brought about an expansion of incandescent lighting on the central-station plan that was more remarkable even than that of arc lighting. Beginning several years later than arc lighting, within a decade incandescent lighting was represented by two-thirds as many local companies. More significant than all else, it was firmly establishing itself in the American home, which meant that hundreds and thousands of dwellings in the cities and larger towns were being wired for electricity. And it was soon vying with the arc lamp in the lighting of factories, mercantile establishments, hotels and theaters—interiors in which the



THE FIRST SWITCHBOARD
"Electrical World," April 26, 1884

***June 7, 1884*—It is stated that Professor Thomson has perfected a system of incandescent lighting for the company (American Electric & Illuminating Company) and that the lamp will be made and used at once. The company is also nearly ready to begin the use of electric motors in connection with the new Boston station for the transmission of power for manufacturing purposes.**
—"Electrical World."

arc lamp had won a considerable footing. It became evident, by the beginning of the 1890's, that incandescent lighting was completely acceptable to the public for the illumination of living rooms, bedrooms, kitchens, offices, foyers and innumerable small interior spaces in which illumination by arc lighting was impracticable.

This meant that gradually and steadily the incandescent lamp was becoming a factor in the social life of the people. It made it easier to create in the home the most favorable conditions for man's night-time activities. It drove out from the home every vestige of drudgery that was involved in overcoming the darkness. Light could now be instantly summoned by the mere pressure of a finger. Such a new and thrilling experience was something which every one enjoyed and sought after. The irrepressible yearning of the human race to prolong the hours of light could now be accomplished with minimum effort, and consequently there was a great demand for incandescent lighting.

It was a demand which for a time was not difficult to satisfy. The expense of wiring premises was usually adjusted on a reasonable basis; the incandescent lamps, although costing a dollar in 1880, were scarcely half that price ten years later, and the rates charged for electric current were carefully worked out to provide a reasonable profit for the local lighting company and offer to the consumer, considering the superiority of this method of lighting, a relatively low cost. Growth was so pronounced, under these conditions, that every well-managed local lighting company was soon in a healthy and even a flourishing condition. People wanted electric lighting more and more insistently, and as the inevitable result the central-station industry grew into a permanent and increasingly conspicuous factor in American economic life. Its securities began to be sought after as sound and profitable investments.

Growth was greatly aided by the technical developments of the period. In the summer of 1883 the late William Stanley experimented with induction coils and had constructed several so-called "reducing converters" (transformers) to operate incandescent lamps. In March, 1886, he erected an experimental plant at Great Barrington, in which he had seven converters arranged in multiple arc and supplying over 100 lamps. George Westinghouse, for whom he was working, and whose company became the owner of his inventions in this line, began immediate preparations for the manufacture and commercial exploitation of his system. The commercial introduction of the constant potential alternating-current system with transformers followed promptly, and this may be said to mark the beginning of the commercial development of that useful system in this country.

It was increasingly evident at this time that electricity was capable of great things, but for its expansion there was need of an integrating force, a unification of the

systems already in existence. The desired new technical elements were found in the multi-phase alternating-current generator and the steam turbine. Large power stations then became possible and electricity from these stations was transmitted to the various existing distributing systems. The multi-phase current offered the great advantage that it could supply directly, or through frequency changers, all existing alternating-current transformer systems, and at the same time, through the medium of motor-generators or of rotary converters invented by Bradley, it could be changed, or converted, to direct current of the required voltage. Thus the multi-phase system became the needed unifying factor, dovetailing the old and the new and permitting progress by evolutionary methods.

The industry, through this period, had produced capable, far-visioned executives and had displayed a continual tendency to strengthen itself, financially and technically, by consolidations. Samuel Insull, the builder of the great Commonwealth Edison Company of Chicago; Charles W. Edgar of the Boston Edison Company, John W. Lieb, long associated with the New York Edison Company—all men who came up through the early Edisonian organization—Alex Dow, leader of the Detroit Edison Company; W. S. Barstow of the Brooklyn company, and many others whom I might name, had applied masterly insight and understanding of the possibilities of the field. In their respective zones of operations they had exerted their efforts to serve the constantly broadening fields of their communities by the most progressive policies.

Central-station executives in general had seen the beginning of an extraordinary expansion in these fields. Electric lighting had been followed by electric power and—in the industrial field particularly—electric heat. Expansion into these new domains of service had been facilitated by the influence of the incandescent lamp, which caused premises to be wired in the beginning and which acquainted people in general with the possibilities of electricity. The incandescent lamp thus directly prepared the way for the introduction of electric power, both in the factory and the home. The demand for electric power caused a further growth in the business of the local companies. Early in this period, also, the dictates of economy and efficiency had led to the combination, in many communities, under one management, of the arc-light company and the incandescent-light company. These crowded years were prolific with operating problems and the builders of America's electric light and power business in dealing with them had disclosed constant economic strategy.

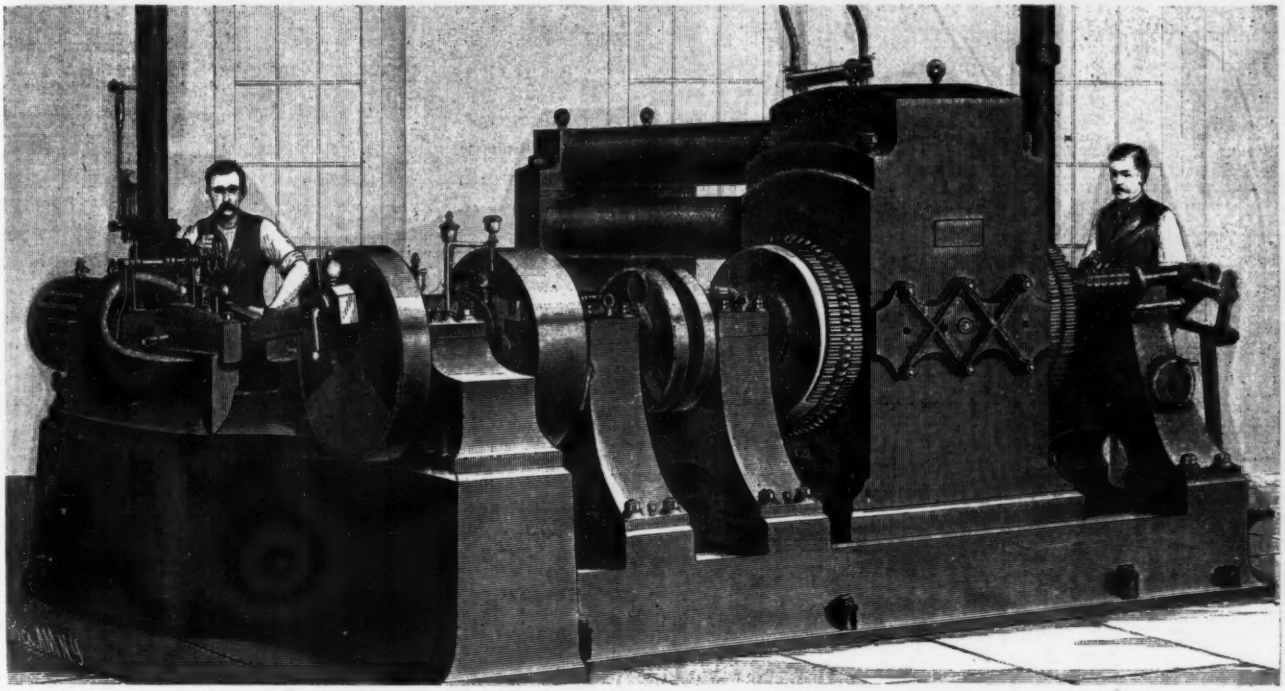
It was clearly recognized, as time went on, that electric service for light, power and heat was a form of natural monopoly. Electric light and power companies, especially as they broadened in scope, were early perceived to be public service corporations. The regulation of such companies by local municipalities or, later, by state public service commissions had its beginning subsequent to the period when arc and incandescent enterprises in the same communities united as a single electric utility company. Throughout the early period of electrical development it had been expected that the existence of rival electric light companies in the same city would result in a healthy competition. The incandescent lighting company, it was supposed, could engage also in arc lighting and the arc-light company could enter the incandescent-lighting field. In practice, however, this did not prove to be the case. The duplication of plant and of service lines proved a burdensome expense which necessitated rates unduly high. There could not exist, with profit to the company and fair charges to the consumers, two electric utility enterprises in the same town. These companies consequently consolidated, a perfectly natural step in the interests of economy and efficiency, and these consolidations had the immediate effect of emphasizing the monopolistic aspects of the business.

Up to this time the political relationships of the electric light companies had been confined to the acquirement of operating charters and franchises and of the municipal contract for street lighting. No serious political obstacles were allowed to hamper the establishment of the local companies, but the increasing magnitude of their operations raised the question of regulation in the public interest. Such regulation was a natural accompaniment of the growth of the industry, and its influence upon that growth, broadly considered, has been constructive, as well as beneficial, to the consumers.

This, too, was the period during which the financial holding company had its birth in the field of electrical development. That important step, at the time a distinct but valuable innovation in our industry, introduces the name of Charles A. Coffin, the first president of the General Electric Company. Mr. Coffin, before becoming identified with the old Thomson-Houston Company, was already a successful manufacturer and merchant. He was also a director in banks, but was not regarded as a professional banker. His work, however, as the active executive of the Thomson-Houston Company, and afterward of the General Electric Company, placed him in the first rank of financial men. He represented the type of banker who creates wealth, rather than the type which only conserves values, or trades in values already in existence.

He saw from the first the need to conserve the slender strength, financially speaking, of the electrical manufacturing companies, and recognized the great savings which would follow in overhead, in better utilization of material, of patents, and of human material, skilled engineers and inventors, by consolidating weak competing companies. I believe that he was the first to adopt the idea of the holding company to the financing of the light and power industry.

By this method, coupled with the steam turbine, of which I shall presently speak, further remarkable expansion was made possible. At that period the urban field had been well covered by the long-established light and power companies of metropolitan centers. Not so the small towns and the rural villages. The local electric service companies in those places were lacking in financial stamina and consequently were restricted in their profitable operations. Yet the people living in those communities also desired electric lamps and electric motors, and they were demanding these conveniences as insistently as once such things had been demanded by the urban dwellers. The financial holding company had the ultimate effect of supplying needed capital to these rural electric operating companies and thereby enabling them to finance the extension of service to all potential customers in their respective communities. Before many years the small-town population was being



EDISON'S FIRST JUMBO AT PARIS EXHIBITION, 1881

served as adequately as the urban population with electric light and power; these local companies were also in a prosperous condition, and the electrical industry as a whole had become more stable than ever.

Between 1900 and 1910 there came a tremendous speeding up of electrical development through the steam turbine, exemplified in the Parsons and Curtis types. In my opinion, the most important single material contribution to the enormous expansion of the electric power industry has been the creation of the mammoth steam-turbine units. The steam turbine's unique position in the industry has not been so dependent upon its thermal efficiency as upon its low capital cost, its reliability and simplicity, and, most important of all, because of the fact that an enormous amount of power can be concentrated in one unit. It represents the mass production idea as applied to the business of manufacturing power.

We stand thus at a half-century milestone in the rapid and vivid history of the electric light and power business. Fifty years have passed since the electrical art, in the practical, everyday business sense, came into the world as an infant among the material achievements of man. It has since grown into a marvelous youngster, with a wondrous future before it. It is still young, especially as compared with other human enterprises and arts; yet it so nearly dominates our material life today that if electricity were suddenly removed from the world society would be paralyzed and human affairs would become chaotic. Our twentieth century civilization depends upon electricity about as much as man's physical life depends upon oxygen.

And what of the future? It is not the professional function of the engineer to turn prophet, nor is it usually to his taste to endeavor to lift the veil of the years to come. Nevertheless, in the present status of the electric utility business in this country, considering the trends which already are showing themselves more or less clearly, it is not particularly difficult to foresee certain probable developments that will come about either sooner or later. A continued expansion of the industry, resulting from the still greater use of electricity, is one of the inevitable occurrences to be confidently expected.

At the present time about 70 per cent of American homes are connected to electric supply lines. The actual number, in round figures, is 20,000,000. Although all of these 20,000,000 homes are electrically lighted, there are great numbers of them in which such electrical apliances and domestic electric equipment as refrigerators, ranges, dish-washing and clothes-washing machines, ironers, sunlamps and sewing machines are still unknown. This is a potential field which eventually will make great additional demands upon the service lines of electric light and power corporations. The service field that is still untapped in that 70 per cent of the nation's homes at present wired for electricity, not to mention the normal growth in population which will cause the building of new homes, is reassuring as to the years ahead.

Of the homes which belong in the 30 per cent still unconnected to electric supply lines by far the greater number is to be found among the farmsteads standing more or less isolated from existing electric distribution systems. The nation has a total of some 6,000,000 farms, but only about 700,000 of these are electrified. The electrification of a farm is a different proposition from the electrification of a city or town dwelling. Not only is there the same normal home field for the application of electricity but there is also the great potential expansion to be expected in making electricity function as the hired man and the farm hand. Already there are numerous practical applications of electric current to farm work, and the material benefit to the farm has been abundantly demonstrated upon those 700,000 farms which thus far have been able to obtain electric service. It is estimated by the United States Department of Agriculture that 16,000,000,000 hp.-hours are consumed an-

nually upon the farms of America, of which only 900,000,000 hp.-hours are handled electrically.

Equally impressive, as auguring for future electrical growth, is railroad electrification. At present only 2 per cent of our total railroad trackage is operated electrically. Economic, rather than electrical, problems have delayed this development, for the progress thus far accomplished has revealed quite convincingly many practical advantages in the moving of trains by electricity instead of by steam. The electrification of the Pennsylvania Railroad between New York and Washington will emphasize its value. It is reasonable to assume that railroad operations will constitute for an indefinite period a field for the expansion of electricity's service to the world and for the further growth of the industry.

Such growth in these several fields will, naturally, present new technical problems to electrical men. But we need have no apprehensions as to the ability of electrical engineers to meet and master these conditions. There is already much new knowledge in our electrical laboratories and among our electrical engineering staffs which enables them to keep ahead of the demands of the moment. New technical problems will tax, but will not defeat, the skill of engineers and executives.

We passed through the period when the relatively small turbine-generator station gave way to the very large generating station. The number of the small central-generating plants was relatively large, but at that period, the period previous to the war, the capacity of the average turbo-generator was not above 35,000 kw. Then as capacities increased, and more or less parallel with the development of large financial holding companies, there came into existence a small number of large-capacity generating stations instead of a fairly large number of small-capacity stations, until we have at present, as the maximum attainment in that direction, the successful operation of a plant in which a turbo-generator unit rated at 208,000 kw. is installed.

Even though the capacities of the monster generating units of today may not be exceeded in the future, we may expect marked progress in other respects. The development of higher steam pressure is one of these. At present the maximum pressure in commercial installations is 1,200 lb. per square inch, but this is certain to be materially surpassed. Engineering data already have been accumulated permitting the application of higher pressures in boilers. The materials at present entering into the construction of boilers have proved capable of withstanding higher pressures than those now actually in use. The outlook is favorable for greater progress in this direction, with attendant operating economies. It is also to be expected that further development in fuel economies will eventuate, especially if the impressive progress of the past is an index. Future turbo-generators of no greater capacities than the largest now in service may develop greater over-all efficiency and hence greater operating economy by reason of higher steam pressures and less fuel consumption per kilowatt of generated electricity.

Beyond all possible improvements in steam turbines of the conventional type we have, in addition, the potential economies which will be introduced by the mercury turbine. Slowly but surely this piece of apparatus is passing out of the strictly experimental stage and entering the stage of definite commercial exploitation. Its theoretical benefits, which are definite and considerable, have been steadily translated into practical realities. Much operating experience with the mercury turbine has been derived from the one unit so far installed in a commercial station, and much more is anticipated from the two units—each twice as large as to capacity—which will shortly be installed in other stations. Apparently it is merely a question of time when the notable operating economies made possible by the mercury turbine will become available to the central-station industry, precipitating a period of much cheaper production costs.

All this will have its inevitable effect upon the electrification of America. Such pronounced advances in the process of generating electricity in the central station may simplify the problems of transmitting and distributing the electricity after it is generated, so that areas not yet reached by electric service lines may attain a place upon the electrical map. Transmission and distribution have always been a major item in the cost of delivering electric current to the consumer. The highest transmission potential at present in commercial use is 220,000 volts, and while electrical engineers can design apparatus for use at much higher pressures, to do so has not yet proved economically sound.

Never in the past has electric service to the American people been so reliable as it is at present. Many technical developments—some of them forming fascinating stories in themselves—are responsible for this. None, however, is so fundamental and so universal as the two factors of lightning protection and interconnection. There was once a period when electrical systems were, to a considerable degree, at the mercy of lightning. This resulted both in property loss to the electrical companies and vexatious interruptions in service to the consumer. Such is no longer the case, however, owing to continual and extensive engineering investigations of lightning, in laboratory and field, and the application of effective protective methods developed from these investigations. Even should an electric utility experience upon its own system some emergency of serious proportions, which ordinarily would interrupt its service to the public, the interconnection methods now in use permit the instant tapping of surplus electrical energy from the system of another company. Thus an electric utility maintains its own service without a break. The practice of interconnection, which is one of the most definite benefits contributed by the financial holding company, has now been established over wide territories throughout the land. It is safe to say that dinner may now be cooked in the electric range without danger of the family's going hungry because the electricity is cut off before the meal can be served.

Four of the twenty men present at the opening of Pearl Street station are still living. They are Charles L. Clarke, retired staff member of the General Electric research laboratories at Schenectady, N. Y., then chief engineer of the Edison Electric Light Company; H. A. Campbell, supervisor, Second District, Bureau of Substations, New York Edison Company, then Edison's superintendent in charge of construction at Pearl Street; Samuel Insull, then Thomas A. Edison's private secretary and financial manager, and W. H. Meadowcroft, secretary of Thomas A. Edison, Inc., then private secretary to Major S. B. Eaton, who was vice-president and general manager of the Edison Electric Light Company in 1882.